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OF

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34

1917/1918

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Papers and Transactions for 1917

AND

Proceedings

OF THE

Thirty-Fourth Annual Meeting

AT

HARTFORD, FEBRUARY 19 AND 20, 1918

* * *

New Haven
THE TUTTLE, MOREHOUSE & TAYLOR COMPANY
1918

Connecticut Society of Civil Engineers

ORGANIZED AT BRIDGEPORT, JANUARY 15, 1884

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CONTENTS

President Buck's Address 1

Notes on Sanitation in Russia and Japan. By C.-E. A. Winslow 7

Opportunities for Safety Engineering in Construction Work. By D. Van Schaack 27

New Haven Sewage Experiment Station. By F. W. Mohlman and W. S. Sturges, Jr. 35

Derby Bridge. By R. L. Saunders 52

Safety Engineering and Accident Prevention in General Contracting. By L. D. von Woedtke 60

The Construction of Camp Devens. By V. T. Goggin 68

South Street (Hartford) Cutoff and Other Sewer Construction in Tunnel. By W. S. Brewer 80
  Discussion 85

The Proposed Building Code of the City of Hartford. By G. L. Mylchreest 87
  Discussion 96

Hartford Pavements. By R. J. Ross 98
  Discussion 106

Summer Meeting 117

In Memoriam:

  William Henry Miller 118
  Clarence Browning Vorce 120

Abstract of Proceedings 122

Constitution 132

By-Laws 134

Charter Members 140

Alphabetical List of Members 141

Geographical List of Members 154

Honor Roll 157

LIST OF EX-PRESIDENTS

WITH DATES OF SERVICE

*B. Hull	1884, 1885
Charles M. Jarvis	1886
Charles E. Chandler	1887
Charles H. Bunce	1888, 1889
*F. Floyd Weld	1890
E. P. Augur	1891, 1892, 1893, 1894
Wm. G. Smith	1895, 1896
Robert A. Cairns	1897, 1898
Edwin D. Graves	1899, 1900
Henry J. Kellogg	1901
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Frederick J. Easterbrook	1909
Shepard B. Palmer	1910
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A. William Sperry	1912
Sheldon E. Minor	1913
George K. Crandall	1914
Charles C. Elwell	1915
Clarence Blakeslee	1916
Henry R. Buck	1917

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* Deceased.

PRESIDENT'S ADDRESS.

It is a great pleasure to greet you at this, our thirty-fourth annual convention. Never before in the history of our Society have we met under conditions of such grave importance to us. We are in the midst of a great war; over a score of our members have already gone into uniform, and the thought of war is with us always. It gives to this meeting a different character from those which have preceded it.

Last fall I took a little group of boys to the Big City. We went on the steamboat through the Sound, and we were on deck at sunrise as we entered the East River. The war seemed very near when we heard the reveille from Fort Schuyler, and saw the khaki tents that overflowed all the level land around its grey bastions. The boys were on tiptoe with excitement at the sight of the slate-colored submarine chasers behind College Point, and we could think of nothing else than why they were there, and what they were doing, and what might happen to our dear country if our boys were not on duty there, and at their posts, everywhere, ready!

Suddenly, through the brown haze of the city's smoke, we saw a faint arch rising lightly, far above the roofs of the city's buildings. A black rainbow it seemed, but a fixed rainbow, graceful yet beyond question strong, the easy curve of its arch blending with the heavier masses at either shore, the Hell Gate bridge! No more thought of the patrol boats now, of the tents, and the soldiers. Here was a sight that drew all our attention from the temporary things beneath it. This wonderful arch of steel would endure, carrying all burdens that might come upon it, for generations after the war had been won and the tents and picket boats of our hasty defence had been replaced by the ordered patrols of an international army. Here was the substantial foreshadowing of a time when commerce shall flow unhindered wherever the needs of man require; the steel bow of promise in the city's clouds. We watched it grow, from a low linkage between two shores, simple and monumental, to a lofty structure, complex, intricate, stretching far above the tallest masts of the shipping, and dominating every other sight or thought.

Surely, we thought, no life could be better worth living than that which leaves behind it a monument so enduring and yet so graceful, so wholly practical, and yet so suggestive of the higher interests of humanity.

The boy said, "Gee! I'd like to be an engineer."

Now all this may suggest to us that in spite of this terrible war, in which at last, thank God, we have a part, the work of the engineer must continue beyond and above its distractions. We all of us wish to give our best and our utmost to win the war. And we must and shall win it, decisively. It is unthinkable that it should be otherwise. Each one of us will live frugally, loan to the Government all that we can save or all that we have, and serve to the utmost of our ability and opportunity.

But not all of us can go to France. We must, the majority of us, keep at our daily tasks, each trying to do his own work better and to do in addition the work of those who leave for more unselfish service. But unless we take the longer look beyond the terrible details and the heavy demands of war and see the generations of the future rising above the fogs and uncertainties of the present, we shall be unable to reap the full rewards of our certain peace. In Europe, thousands upon thousands of the men who held most of civilization's promise have been ground by the juggernaut of war into the foundations of the World's liberty. They have died to build strong our future democracy, but we must not forget what all these thousands of individuals could have accomplished if this supreme sacrifice had not been required of them. They were the engineers-to-be of the next generation. Theirs were the minds which the world had beeen counting upon to plan the steel rainbows of the future, to work out the great problems of our national utilities, to answer the questions which are being asked more and more insistently by our swelling cities. Lacking these minds, the world will look to us here in America to fill the appalling gap in the ranks of our profession when the period of reconstruction begins. Let us not become too engrossed by the problems of the present to lift our eyes to this appealing need of the future.

Now, this Society has a place right in this tremendous problem. When we reflect that the Senior Society of the profession in America has met continuously only a bare fifty years, our life of a third of a century seems quite respectably venerable. We are one of the oldest engineering societies in the country, we are the only organization of civil engineers in this State, and we trust that we occupy an honorable place in the minds of the men about us. Heretofore we have been content with just about this, but to-day there is a new quickening of the spirit which is especially manifest in our profession. It is no longer enough for us simply to exist as an honorable organization filling a modest place in the background. We must lift our eyes to the bow of steel! We must prepare, now, for the place in the world which our profession will be called upon to fill in the future.

Now, a generation before the birth of our Society the Civil Engineer did not exist as an appreciable force in the community. While the average citizen looked up with respect to the ministers and doctors, and he also looked up to the members of the legal profession, there was no engineering profession at all. We should not expect, therefore, that it would receive in the minds of laymen the instinctive recognition granted to the other three patriarchs whose beginnings run back to the days when no one was sick or sinful and damages were settled on the person rather than from the purse.

Be sure the engineer was there, too, in those days of Eden; Tubal Cain was a good mining and mechanical engineer, considering the text books he had to study from, and Noah's pontoon carried such a load as no naval engineer of to-day would dare figure for. But the engineer of those early days did not advertise his work with the mummery of the medicine man nor seek to hide his methods under the camouflage of a foreign tongue; no, he was content to be merely a humble, useful member of society, making no noise about his work, but quietly, efficiently, faithfully doing the work that needed to be done, that no one else could do, and doing it well. And, gentlemen, he's doing it yet.

But to-day we live in a different world. Mankind is the same, yes, but distance no longer exists, geography has been eliminated, time has a new meaning.

No longer can a man live on his own farm and depend solely upon the products of his own village.

No state and no nation can feed itself or guard itself regardless of others. We can neither live alone nor act alone.

If one man is more responsible than another for this change in the world it is the engineer. More and more he is being called upon to speed faster the wheels of industry, to widen the broad channels of communication. He is asked to undertake the impossible, and he does it. The steel bow across Hell Gate has become commonplace and he is ready to span the Hudson. The tunnels under that mighty stream, once thought impossible of completion, are quadrupled and he now builds his tubes above the river's bed.

He is expected, like the colored preacher, to define the indefinable, to explain the inexplicable, and to unscrew the inscrutable. No longer can he confine his interests to mere problems of construction. To-day he is in council with financiers and administrators and has not only answered their questions but has shown them the way. To-morrow it will be the expected thing that the successful engineer shall be a real leader in the community.

This cannot be done by the engineer of the old school, whose work is his only pleasure and whose modesty is a vice. It will require a mind differently and more broadly trained, almost a different type of mind.

How can our Society help to develop the engineer of the future, the broad-gauge, compound, high-pressure professional man who already exists as a hand-made article, but who is demanded in terms of quantity production?

If the slogan of our profession in the past has been service, that of the future will be coöperation. Engineers must coöperate with their neighbors in the work and politics of the community.

The very word engineer has the same root as engine and carries the same idea of power, of making things go! There is room for more go in most of our public affairs and the engineers should help to put it there.

As an organization we can popularize the profession of which we are so proud. We ought not only to do things but to let the public know that we are doing them. It is surprising how interesting to an outsider one's work can be made, the mere day's work of any of us. There is a wealth of material for engineering stories right here in Connecticut, which in many cases will never be written if the real interest and value of their work is not called to the attention of the men in charge. Our organization can coöperate with the newspapers and get these things into print. Our newspapers are always eager for interesting and timely articles and it is a disgrace to our profession that the stories they print on engineering subjects are so few and so full of technical errors. The Cleveland Engineering Society has done wonderful work in this direction and I commend to your serious attention a paper by their secretary which appeared in the Annual Report of the Ohio Engineering Society for 1917. This is one of our exchanges and every member of this Society has received a copy.

There is room for more local meetings of this Society. We have had purely social meetings and they are of great value, but they should not be of merely social and selfish value. Really professional local meetings with technical papers and discussions can be arranged with pleasure and profit. Our third local meeting of 1917, the one last July, was the most largely attended local meeting we have had. The social element was not forgotten; we had a luncheon, but about four-fifths of the time was occupied by a talk on a purely professional subject, The Quebec Bridge by Prof. Ellis, a Middletown man then living in Hartford.

We can coöperate with our schools in the education of our own and our neighbors' sons as civil engineers. The technical schools to-day are in flux as never before. Courses are being modified, and will be further altered after the war, to suit as closely as possible the needs of the day, and the faculties of these schools are eager to know what the profession requires of their graduates. We ought to think about these subjects and we ought to give expression to our thoughts. If it be done seriously and tactfully such work will be welcomed and will have great value.

We need to advertise our work to the boys. Remember they are the engineers of the future, and they will enter or avoid our chosen calling according to the colors in which we paint it for them. A live boy leans naturally toward civil engineering. He knows that George Washington was a surveyor and he likes what he sees most of in our work, the clean outdoor duties of our field men, with tangible rewards for honest work. We should coöperate with the agencies that work with boys so that we may influence the greatest possible number; Boy Scouts, church groups, boys' clubs. There is no professional man to-day who can so appeal to and influence our boys as the civil engineer, if he only will. We should show our boys that we love our profession and that it offers great rewards of usefulness and happiness to the right type of man. If we tell the boys, as Charles M. Schwab has lately said, that the technical education of an engineer is the best possible training for modern business life, then we will recruit more of the right type of young blood and contribute to the broadening of our profession, which it so sadly needs. Our Society should see to it that our work as individuals and our doings as a profession are published in such a way that every one with whom the boys talk will feel that this is true.

NOTES ON SANITATION IN RUSSIA AND JAPAN

C.-E. A. Winslow, Professor of Public Health, Yale School of Medicine;
Member, American Red Cross Mission to Russia.

It was my privilege to spend the summer of 1917 in Russia, as a member of the American Red Cross Mission sent out to offer the fraternal assistance of the American nation to a people spent with three years of struggle against German imperialism and racked with the birth pains of a new democracy. One of my colleagues on the Mission, Prof. G. C. Whipple of Harvard and the Massachusetts Institute of Technology, has described our trip and some of the general results accomplished in the Journal of the Boston Society of Civil Engineers for December, 1917 (Vol. IV, p. 393). The work of civilian relief organized last fall has been going vigorously forward all winter under the direction of Major Raymond Robins, and we have reason to be proud of the work that has been, and is being, accomplished in the relief of the suffering and in the cementing of bonds of friendship between our Republic and the new Democracy to the west of us.

My own work in Russia, aside from the organization of plans for child welfare work in Petrograd, was a study of the public health organization of Russia which presents many interesting features. The main results of this survey are presented in Public Health Reports, the weekly bulletin of the United States Public Health Service, for December 28, 1917. The present paper aims to review in greater detail certain of the observations which we were able to make in regard to sanitary engineering problems, in Russia and in Japan, where we were most hospitably entertained on our way out.

WATER SUPPLY OF YOKOHAMA.

The general history of water supply sanitation in Japan was briefly reviewed and the water works at Tokyo, Osaka, Yokohama, Kobe, Nagasaki and eight smaller towns described by Mr. George

A. Johnson in a paper presented at the Twenty-Seventh Annual Convention of the American Water Works Association, entitled, Some Notes on Oriental Water Works. Mr. Johnson's paper prepared us to find examples of very modern and efficient water supply engineering, but it was surprising to learn how rapid developments have been in recent years.

The Yokohama Water Works were the first modern water works to be built in Japan, having been designed by an English engineer, General Palmer, in 1885. They were originally planned for a population of 70,000, but were extended in 1902 to provide for 300,000 people, and in March, 1915, new works were built (under the plans of Dr. R. Hara, Chief Engineer), bringing the total capacity up to twenty million gallons, sufficient according to Japanese water consumption estimates for 800,000 people. The complete works include two reservoirs with a total capacity of 12,401,000 gallons, 16 filter beds with a total area of 314,824 square feet, and 4 settling basins with a total capacity of 2,851,000 gallons. In 1914 the actual consumption was 5,833,000 gallons, or fourteen gallons per capita. There were

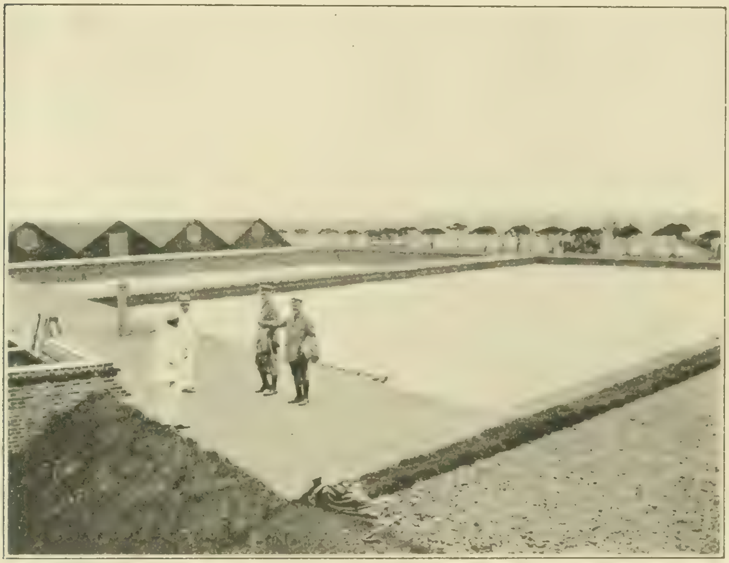

FIG. I. NOGIYAMA WATER FILTRATION PLANT, YOKOHAMA.

44,285 dwellings supplied in 1914 and 323,520 people; 4,124 of these dwellings including 103,100 people were on metered service.

The filter beds visited by Professor Whipple and myself were the old beds at Nogiyama built partly in 1886 and partly in 1902. The water flows to this plant by gravity from the Doshi River near the foot of Fujiyama, a distance of some thirty miles. The water is received in small receiving wells, but being fairly free from color and turbidity is distributed almost at once to the filters. The filter beds themselves are six in number with a total area of 1.2 acres. The tanks are of masonry and brick and the sand is of good quality averaging two and five-tenths feet in depth on eighteen inches of gravel. There are two baffled clear water basins providing a storage period of about twelve hours. A general view of two of these beds (with Major Whipple and Captain Malcolm Pirnie of our Mission in the foreground) is given in Fig. 1.

Up to 1914 this plant furnished all the water for the city, and in 1913, 5,188,000 gallons passed through this area of a little over one acre. With the new plant opened in 1914, and including nearly six acres in addition, this heavy load has been relieved. The sand is washed by hand in concrete troughs (seen at the left of Fig. 1). The typhoid rate for the city of Yokohama for 1914 according to the figures given in the Summary of the Yokohama City Annual Statistics, No. VII, was 14.4 per 100,000, which would indicate that the water supply is of excellent quality.

WATER SUPPLY OF TOKYO.

An even larger and more modern plant is to be seen at the capital city of Tokyo (population in 1914, 2,244,796). These works were originally designed for a population of 1,500,000 to deliver 45,000,000 gallons per day and were put in commission in 1898. A 33⅓ per cent increase in settling basin and filter capacity was made in 1909, and in 1914 the amount of water filtered was 6,385,892 gallons per day, or about twenty-two gallons per capita.

The supply is brought by a main canal from the Tama River to the purification plant at Yodobashi, from which point it is delivered to the city. The length of the canal from the Tama River to Yodobashi is about twenty-five miles. At the Yodobashi station there are four sedimentation basins with a total capacity of 11,928,429 cubic feet, twenty-four filter beds of one acre each, a service reservoir and pumping station. There are two other service reservoirs for the lower levels of the city. The capacity of each of the three reservoirs is 1,000,000 cubic feet. The total length of the distribution piping is 478 miles, twelve sorts of pipes being used varying from 100 to 1,100 mm. in diameter. At the end of September, 1912, the number of taps in use was 155,453, supplying 280,116 houses (about half the dwellings in the city). The city controls 22,486,790 Tsubo (18,584 acres) of land for water works purposes and extensive aforestation work has been conducted on the watershed of the Tama River. Material extension of the works will be required in the immediate future; and plans approved in 1912 provide for a supply of 17,280,000 cubic feet per day. They include impounding reservoirs fed from the Tama River, by an open canal 6.7 miles long, tunnels and conduits of 7.44 miles in length from the lower impounding reservoir to filter beds at Sakai of twenty-three acres area, the total cost of the new system being estimated at 20,720,000 yen.

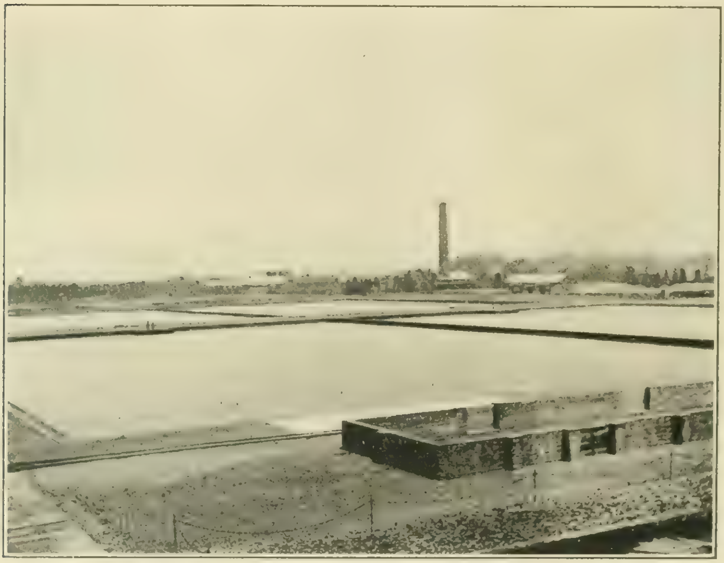

FIG. 2. GENERAL VIEW OF YODOBASHI FILTERS, TOKYO.

The purification plant at Yodobashi which we visited was a thoroughly modern and up to date one. It consisted, as pointed out above, of four sedimentation basins (89,500,000 gallons capacity), twenty-four acres of sand beds and a service reservoir (capacity 7,500,000 gallons). On a basis of the average water supply for 1914 which was 47,894,000 gallons, this would allow a sedimentation period of about forty-five hours, a filtration rate of 2,000,000 gallons per acre per day, and a clear water storage capacity of about four hours.

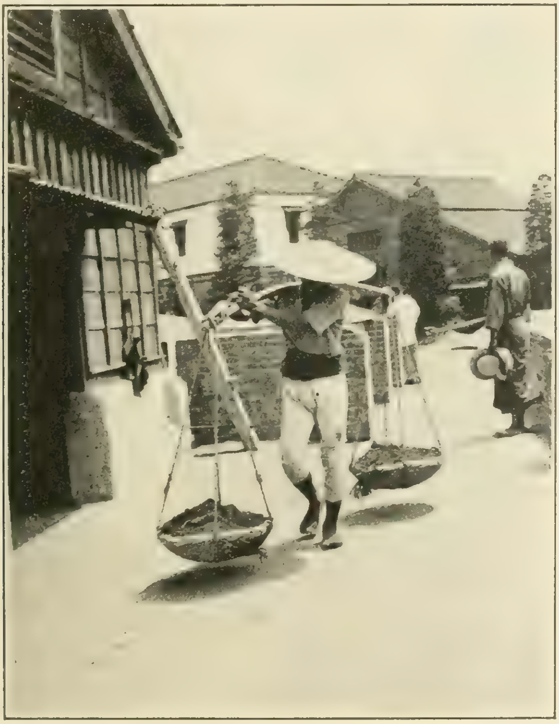

FIG. 3. COOLIE CARRYING FILTER SAND AT YODOBASHI PLANT, TOKYO.

Fig. 2 is a general view of the Yodobashi filters with sand storage bins in the foreground and the pumping station in the distance. The plant is in general operated in accord with the practice which obtains in this country; and the sand is washed in

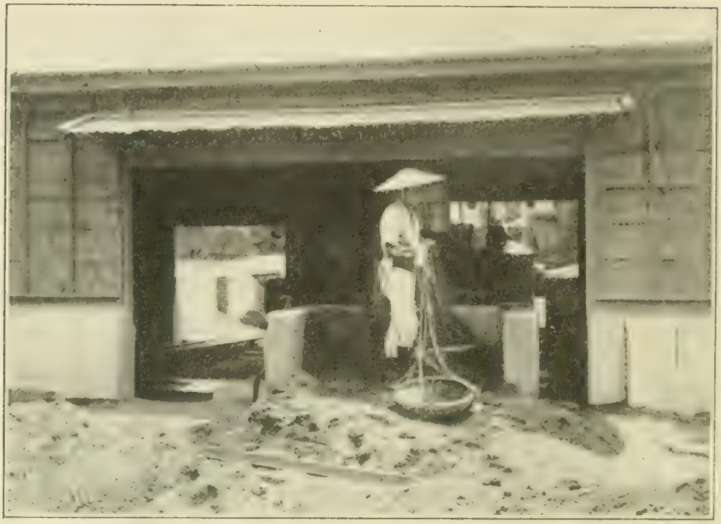

FIG. 4. COOLIE DELIVERING SAND AT SAND WASHER, YODOBASHI FILTRATION PLANT, TOKYO.

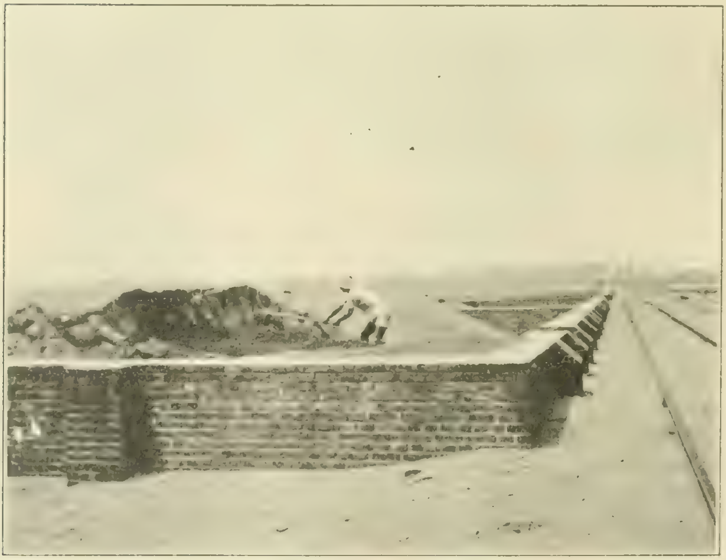

FIG. 5. LEVELING WASHED SAND IN STORAGE BINS, YODOBASHI FILTRATION PLANT, TOKYO.

a washer of the upward-flow type which we generally use. The only striking difference appears in the carrying of the sand from place to place. The Japanese coolie almost never uses a wheelbarrow, but transports his load, whatever it may be, in baskets suspended from the ends of a pole resting on the shoulders. Fig. 3 is a good view of one of the laborers at Yodobashi carrying the dirty sand in this way, and Fig. 4 shows another who has just deposited his load at the sand washer. In Fig. 5 a coolie is seen smoothing over and leveling the sand in a storage bin.

The raw water delivered to this plant is excellent as regards color, turbidity and hardness. The bacteria in the raw water varied from 700 to 2,100 per c. c. in 1914 and averaged 1,316. The average rose to 2,554 after sedimentation and fell to sixteen after filtration.

The typhoid rate for the city in 1914 was 20.8 according to data given in the Thirteenth Annual Statistics of the City of Tokyo.

DISPOSAL OF EXCRETAL WASTES IN JAPAN.

Plans for a comprehensive sewerage system for Tokyo were prepared in 1905, but financial difficulties have prevented more than a beginning. In 1914 there were 52,818.5 ken (about 60 miles) of sewers actually in operation. The system ultimately planned is to provide for a population of three millions with an average sewage discharge of six cubic feet per capita per day. Sewer sizes are to vary from eight inches to thirteen feet, and the total length of street sewers will be at least 2,725,000 feet. There will be three points of discharge, with screens and sedimentation basins at all three and filter beds in addition at one of the outlets. The total construction cost is estimated at 39,890,000 yen.

At present Tokyo, like other eastern cities, depends mainly upon the pail-system for the disposal of excreta. The typical closet seat is a slit in the floor, often with a straight back to lean against, and this slit opens into a vault below. As a rule the vault extends out beyond the wall of the house and the contents are removed from outside by a metal dipper on the end of a long pole. The night soil thus removed is carried away in pails (see Figs. 6 and 7), and is used for fertilizing purposes on the rice fields and in the other processes of intensive agriculture which are carried to such a high point of perfection in Japan.

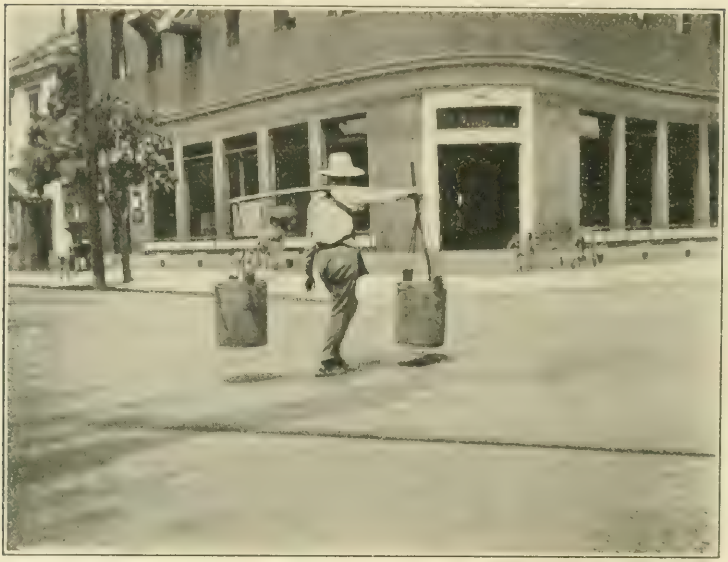

FIG. 6. TRANSFER OF NIGHT SOIL FROM VAULT TO CART, TOKYO.
(See Fig. 7.)

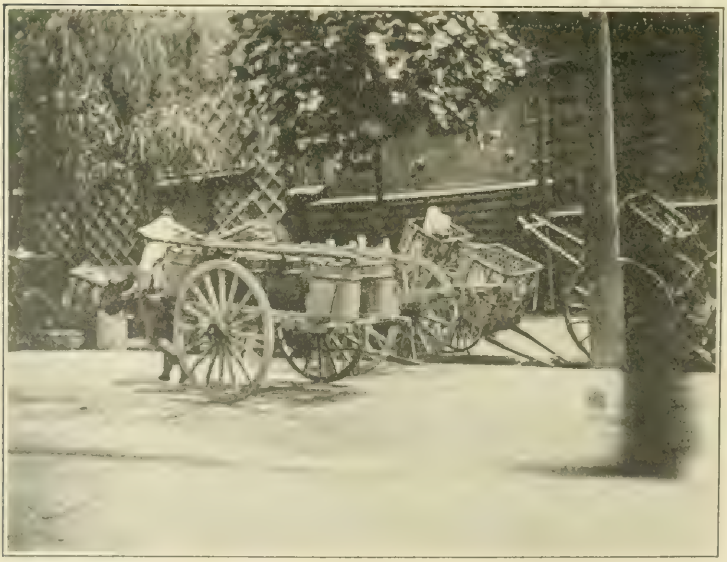

FIG. 7. TWO-WHEELED CART USED FOR TRANSPORTATION OF NIGHT SOIL BUCKETS, TOKYO.

RAILWAY STATION WATER SUPPLIES IN RUSSIA.

All through the East, and in Russia as well, one is constantly struck with the extent to which the practice of cookery can be made to take the place of sanitary engineering. The general use of night soil for fertilizing purposes in Japan might for instance be naturally expected to produce a high typhoid incidence. That it does not exert a more marked effect of this kind is no doubt due to the fact that water and milk are so generally heated before being used, if indeed cow's milk be used as a beverage at all.

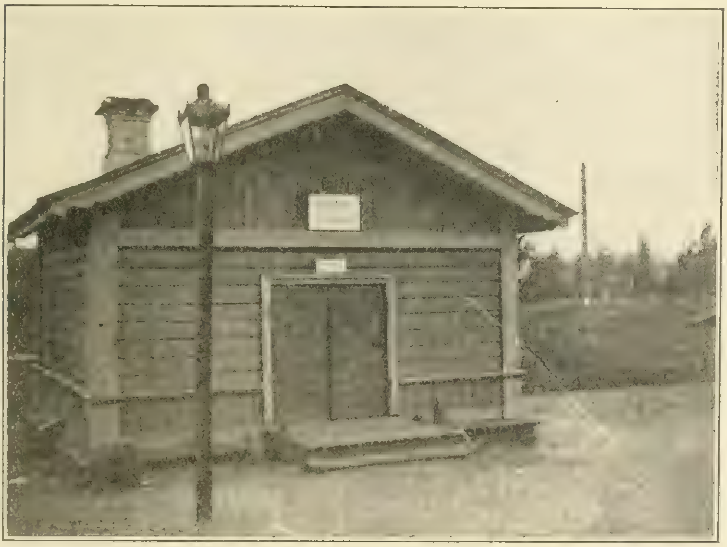

FIG. 8. KIPYATOK OR HOT-WATER STATION ON THE TRANS-SIBERIAN RAILROAD.

In Russia we find the same story. Water purification plants are few and adequate sewage disposal still rarer; but at every railroad station all along the Trans-Siberian Railway, from Vladivostock to Petrograd there is boiling water freely on tap and no one thinks of using the fluid in its normal state. The hot water station or Kipyatok is usually a separate building containing large tanks in which the water is kept constantly boiling while pipes provided with taps commonly extend to the outside (see Fig. 8). As soon as the train stops men, women and children, soldiers and civilians, run out with their teapots in hand and line up before the Kipyatok, rushing for the train again at the ring of the third warning bell. There can be no doubt that this national practice has proved a tremendous factor in preventing epidemics of intestinal disease which must otherwise have attained the gravest proportions.

WATER SUPPLIES OF PETROGRAD.

According to the Russian Year-book there were 1,063 urban communities with populations over 10,000 in Russia in 1912, of which only 219 or 20.6 per cent had public water supplies. Only 167 of the 219 delivered the water directly to private houses. Fifty-nine cities had filtration plants in operation. More recent statistics are not available, but, since the war at least, few new municipal developments have been undertaken.

While much remains to be done in the way of water supply sanitation, the work already accomplished shows in many instances a high order of technical attainment. The two great cities of Petrograd and Moscow in particular have purification plants which are well worthy of study.

The city of Petrograd (population in 1915, 2,319,000), had 664.3 versts (442.8 miles) of water pipe in 1916, and in 1915 supplied a total of about nine billion vedros (twenty-four billion gallons), amounting to thirty-six gallons per person per day. The expenditure for the system in 1915 was 3,002,000 roubles and the income, 5,079,000 roubles.

There are three distinct supplies, the first for the principal part of the city and the Vassilyevsky Island; the second supply for the large Petrograd Island and a part of the Vyborg district (on the north shore of the Neva); and a third supply for the rest of the Vyborg section and the other districts on the north bank.

Ten years ago only the first of these supplies was filtered and the filtration that was provided was obviously ineffective. In the years 1908 to 1910 the city was visited by a severe cholera epidemic, for which the water supply was in large part responsible. Doctors Zabolotny, Zlatogorov, Kulescha and Jakovlev reported at this time (Die Choleraepidemie von 1908, 1909 in St. Petersburg, Veröffentlichungen aus dem Gebiete der Medizinalverwaltung, Bd. II, Heft. 3, Berlin, 1913), the isolation of cholera vibrios from 27 per cent of the samples of raw water at the Main

Pumping Station, from 16.9 per cent of the samples of (untreated) water at the Petrograd-Vyborg Station, and from 10.5 per cent of the samples of filtered water at the Main Pumping Station. Since this unfortunate occurrence the filters at the Main Pumping Station have been remodeled and supplemented by disinfection and filters and an ozonizing plant have been built for the Petrograd-Vyborg supply.

The Main Pumping Station is situated on the southern mainland shore of the Neva, close to the Smolny Institute, which has recently become famous as the headquarters of the Soldiers and Workmen's Delegates. It supplies about 25,000,000 vedros (67,000,000 gallons) a day. Since this intake is near the center of the city with sewers emptying near by, to say nothing of the pollution from heavy river traffic, it is obvious that thorough purification is essential. The treatment plant originally consisted of eighteen filters of the English slow sand type, but they have been reconstructed for use as American rapid mechanical filters by dividing each bed into a sedimentation basin and twelve small filters. On account of deficient capacity this plant has been greatly overloaded and it has been the custom at times to filter part of the water without chlorination and to chlorinate another part without filtration. The bacteriological results of these two methods as well as of the combined treatment for the year 1914 were as shown below.

BACTERIOLOGICAL RESULTS, MAIN PUMPING STATION, PETROGRAD, AVERAGES, 1914.

	Bacteria per c.c.	Per cent positive tests for B. coli in $\frac{1}{10}$ c.c.
Raw water	364	47.0
Filtered water	73	3.0
Chlorinated water	16	.02
Filtered and chlorinated water	5	.007
Mixture as delivered	25	1.3

Great difficulty has been experienced in procuring either alum or bleaching powder since the war, and chlorination is now effected by the use of a sodium hypochlorite solution prepared on the spot by the electrolysis of salt. The electrolytic plant includes at present three batteries of sixteen cells each (a fourth battery was provided for in the original plan). Each cell is 500 x 450 x 400 mm. and contains four platinum anodes and five carbon cathodes. The cells are kept cool by lead water baths. A 9.5 per cent salt solution is used and a current of 830 amperes and 104 volts yields a solution containing thirteen grams of active chlorine per liter. Each battery can deliver 140 kilograms of active chlorine in twenty-four hours and the chlorine is applied to the raw water at an average rate of 1.5 parts per million. Seven and three-tenths kilograms of salt and 6.6 kilowatts of energy produce one kilogram of active chlorine. Assuming round figures of 7.5 kilograms of salt and 7.0 kilowatts of energy the cost, including labor repairs and interest charges, is estimated at fifteen roubles, eighty-four kopecs per pood of active chlorine, which would be about twenty-two cents per pound at the original pre-war valuation of the rouble.

The smaller plant for the Petrograd-Vyborg district is on Petrograd Island and delivers 5,600,000 vedros (15,000,000 gallons) of water a day. Its intake is in one of the arms into which the Neva is divided by its several large islands, and further down-stream than the main pumping station. The plant (built in 1910) is an elaborate one, including ten settling basins, forty-nine American rapid filters, and a Siemens-Otto disinfecting apparatus. The water is first dosed with alum and then passes to the ten sedimentation tanks. These are circular upward flow tanks, each one having a capacity of 13,500 gallons, the total storage capacity amounting to 2.3 hours flow. The water next passes to the forty-nine mechanical filters. Each filter has an area of 135.6 square feet and the downward velocity of filtration is about fifteen feet per hour. The net yield is about 100 million gallons per acre per day. The filters are of the mechanical wash type and as originally constructed consumed the enormous value of 17.5 per cent of the water filtered in washing. By reconstruction of strainer floor and wash water troughs this value has been reduced to 8.8 per cent, and on some filters to 6.2 per cent.

The ozonizing equipment includes two large tanks for drying the air, nine Siemens-Halske air-ozonizing units, and seven disinfecting towers. Each air ozonizing unit consists of sixteen trays, each tray containing six ozonizing tubes. The seven disinfecting towers are circular towers, each about eight feet in diameter and twenty feet high. The water coming from the filter is mixed with the ozonized air by means of Otto emulsifiers as it enters these tanks. After passing upward through a tank it is discharged in a cascade to liberate excess ozone and thence passes to the clear water reservoir of the plant. The ozone apparatus was designed to yield 3.5–5.5 grams of ozone per cubic meter of air per hour and to supply ozone to the water treated at a rate of 1.5–2.0 grams per cubic meter. The plant was designed for only twelve million gallons per day and, being now run at 25 per cent over this capacity, the period of contact with the ozone is too short to secure the best results.

The plant as a whole is handsomely and elaborately built, but is expensive both in construction and operation.

The character of the Petrograd water is carefully watched by the experts of the excellent Municipal Laboratory under the direction of Dr. Y. Yakovlev. During the 1908–1910 epidemic this laboratory made 26,000 examinations of feces and 13,000 of water samples and published the results of its studies in an impressive monograph. The following data for the year 1913 are taken from Dr. Yakovlev's last printed report:

Bacterial Examinations of Petrograd-Vyborg Supply.

	Bacteria per c.c. On gelatin		B. coli Per cent positive tests in					
	2 day count	5 day count	1 c.c.	5 c.c.	10 c.c.	50 c.c.	100 c.c.	400 c.c.
Raw water ..	424	684	98.0					
Filter effluent	25	64		69.9	73.5	98.3		
Ozonized effluent	0.7	3					23.6	51.9

This plant, like the larger one at the Main Pumping Station, is being strained beyond its capacity and it is believed by the authorities that a supply from a new source, probably Lake Ladoga, will prove the ultimate solution of the problem.

The typhoid rate in Petrograd has been consistently rather high. Between 1887 and 1896 it ranged from 34 to 114 per 100,000 and averaged 64, according to figures furnished by Dr. Yakovlev. Between 1897 and 1906 it ranged from 49 to 108 and averaged 79. The rates for the past ten years are given below.

TYPHOID DEATH RATE OF PETROGRAD.—DEATHS PER 100,000.

Year	Death Rate	Year	Death Rate
1907	67	1912	42
1908	111	1913	49
1909	27	1914	28
1910	35	1915	35
1911	34	1916	38

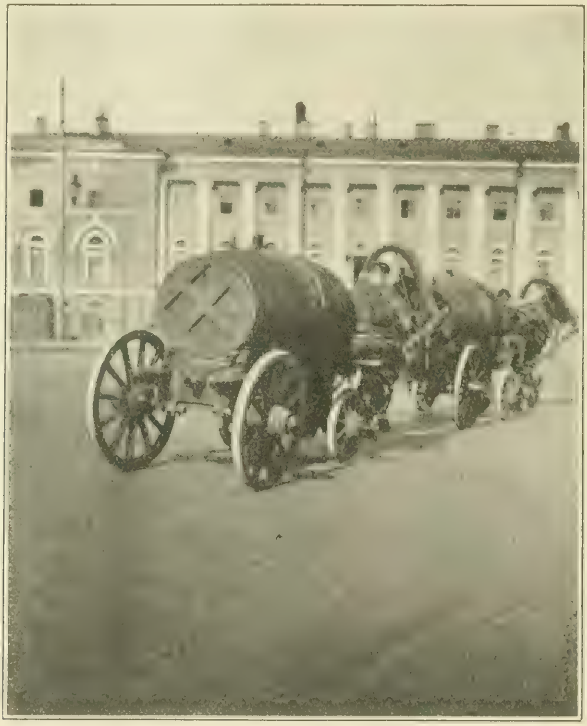

FIG. 9. TANK CART USED FOR REMOVAL OF CESSPOOL CONTENTS, PETROGRAD.

SEWAGE DISPOSAL OF PETROGRAD.

Sewerage and sewage practice, in Russia as elsewhere, lags far behind water supply. M. Serge Stroganov, the expert in charge of the Moscow sewage disposal works, informed me that not more than ten cities have fairly complete systems of sewerage for domestic sewage, and only half of these are provided with disposal works. Aside from Moscow and Petrograd, which will be discussed below, Odessa has a sewage farm, Kharkov, trickling filters, and Nijhni Novgorod, Imhoff tanks.

The waste disposal system of Petrograd is a curiously primitive one for a great European capital. There is an extensive system of sewers in the city, but, as in London and Paris fifty years ago, they do not receive a large proportion of the fecal wastes. The latter are for the most part collected in cesspools which are pumped out at night (at intervals varying from two weeks to several months) into special carts with cylindrical metal bodies (see Fig. 9) which convey the sewage liquids to a disposal station near the west end of Vassilyevsky Island. About 200 such carts reach the station every day. The sewage matters are screened by passing them through Riensch-Wurl screens, the liquid is discharged through a ten-inch sewer at a point seven kilometers out to sea, and the screenings are burned in the adjacent garbage destructor.

This destructor, it may be mentioned in passing, is one of two Heenan and Froude four-unit furnaces, each of which destroys between 5,000 and 6,000 poods (180,000 to 216,000 pounds) a day. They handle only about a quarter of all the refuse produced by the city, the rest being dumped.

WATER PURIFICATION AT MOSCOW.

The population of the city of Moscow was 1,984,000 in 1915. The water supply in the same year amounted to 10,100,000 vedros (27,270,000 gallons) a day or fourteen gallons per capita. There were 9,162 properties connected on January 1, 1916, and 562 versts (187 miles) of service pipe. The expenses of the department in 1915 were 3,645,846 roubles, the receipts, 4,539,794 roubles.

The first water supply for the city of Moscow was obtained by means of an aqueduct from one of the Mystiszczy springs, constructed between 1779 and 1805. This aqueduct at first furnished only 40,000 vedros a day, but the Mystiszczy sources have been gradually developed so that in 1915 they provided 1,638,000 vedros per day, about one-sixth of the total supply of the city.

The other five-sixths of the supply is obtained from the Moscow River and is purified by combined rapid and slow sand filtration.

The construction of this supply was begun in 1900. The intake is on the right bank of the river between thirty and thirty-five miles from the city by water.

I was unable to visit this plant, but a few data from a descriptive pamphlet printed by the city government in 1911 may be cited. The plant as designed provided for coagulation and sedimentation, rapid pre-filtration through mechanical filters and final treatment by means of English slow sand filters.

The rectangular sedimentation basin was built covered and divided longitudinally into two parts each 262 feet wide and 175 feet long, with a depth below the water level of ten feet. The capacity of each compartment was 1,000,000 vedros, giving a mean detention period of fourteen hours for an estimated supply of 3,500,000 vedros (less than half of the actual flow in 1915).

Sixteen pre-filters were provided, each 59.5 feet by 17.5 feet, and containing sixteen inches of sand on fourteen inches of graded gravel. The rate of downward flow was supposed to be five feet per hour.

The English slow sand filters were ten in number with a total area of 6,334 square sajene (a trifle over seven acres). They consist of four feet of sand on twenty inches of graded gravel.

The bacterial content of the Moscow River raw water in 1909 ranged from 165 to 104,000 bacteria per c. c. and averaged 3,406. The sedimented water ranged from 30 to 23,000 and averaged 948. The pre-filter effluent ranged from 25 to 20,000 and averaged 539. The mixed effluents from the slow sand beds ranged from 2 to 108 and averaged 14.

The typhoid death rate of Moscow has been markedly lower than that for Petrograd, being only 14.9 per 100,000 in 1915.

SEWAGE DISPOSAL AT MOSCOW.

Moscow is one of the few Russian cities which have developed a comprehensive system of sewerage and sewage disposal. Even in Moscow only the central district of the city is at present connected with the sewers, and in 1915, 572,442 cartloads of night soil (averaging 28.5 poods or 1,026 pounds per load) were removed from the outlying districts and dumped under highly offensive conditions in areas of low land. The city has been divided into two zones for sewerage purposes and the sewerage of the inner zone was begun in 1892 and completed in 1898. Work on the second zone was begun in 1910. The system is built on the separate plan and its cost to 1913 was 14,523,915 roubles. On January 1, 1916, there were 7,465 properties connected with the sewers, 438 versts (292 miles) of sewers, and a mean sewage flow of 6,768,000 vedros (18,275,000 gallons) per day. This amounts to between seven and ten gallons per capita on the basis of the contributing population (probably not over a third of the total). The operating costs for 1915 were 2,419,187 roubles, the interest charges 1,852,032 roubles, and the receipts 4,679,976 roubles.

The sewage of Moscow is at present disposed of by irrigation at two different areas, one at Lubline, which treats about two-thirds of the total amount (about five and one-half million gallons in the summer of 1917), and another at Luberzy, which handles the remainder and provides space for expansion in the future as the outer zone of the city is gradually connected.

The Lubline farms which I visited are about eight miles from the city, on the left bank of the Moscow River. They include 1,161 dessiatins (3,135 acres) of land, of which about a tenth is under cultivation, cabbages, rye grass, and willows being among the principal crops. The main part of the area is not cropped at all. Of the total area, about half is clay, a quarter peaty soil, and a quarter sand, and operating results differ materially, as would be expected, on the different soils. The clayey and peaty areas treat about 3,000 vedros per dessiatin; the best of the sand areas about 25,000. (Since a vedro equals 2.7 gallons and a dessiatin 2.7 acres, vedros per dessiatin and gallons per acre are interchangeable terms.) The clay lands are low, and are flooded by the river in spring. Doses of sewage of about eight inches in depth are applied to a given area at intervals of from four to ten days, depending on the character of the soil. Two thousand four hundred and eighty-four acres are low enough to be fed by gravity, while the sewage is pumped to the remaining sections. The sewage pumped to the sand beds (essentially intermittent filters), which are on a higher level than any of the others, is submitted to bar screening (2½ cm. mesh) and brief sedimentation (ten minutes). The rest of the sewage receives no preliminary treatment.

The irrigation fields are divided into units of from three to twenty-two acres, and the farms are provided with some 80,000 linear feet of brick and concrete distributing channels, 2,700 feet of wooden channels, 590,000 feet of earth distributing channels, 117,000 feet of drainage channels, 442,000 feet of embankments, 277,000 feet of roadways, and 2,088,000 feet of drains of which the greater part are three-inch tile. One of the higher level beds with its irrigation ditch is seen in Fig. 10.

The construction costs of the irrigation fields to 1911 are given as 2,233,365 roubles and their operating costs at 387,000 roubles a year.

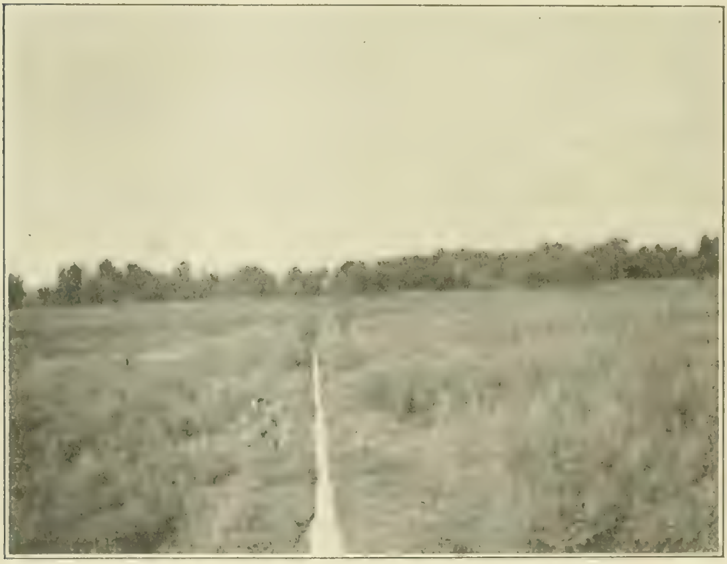

FIG. 10. DISTRIBUTING DITCH ON MOSCOW SEWAGE FARM.

The Luberzy area, which was purchased in 1910–11, includes 1,624 dessiatins (4,385 acres), and will care for 15,750,000 vedros (42,500,000 gallons) a day, according to the estimates of the authorities.

The most interesting thing about the Moscow sewage disposal plant is the admirable experiments which are being conducted on various alternative methods of treatment under the direction of M. Serge Stroganov, who has made exhaustive large-scale studies of Imhoff tanks, contact beds, and trickling filters (the latter equipped with rectangular and circular Fiddian distributors as well as with American type spray nozzles), and is now devoting particular attention to activated sludge treatment. When I visited the plant four experimental basins were in operation, treating 50,000 vedros (135,000 gallons) a day by the activated sludge process with excellent results (see Fig. 11). The tanks are about eight feet in depth and are operated on the fill-and-draw plan with four hours' aeration and twenty to thirty minutes' sedimentation. The air is distributed, not through filtros blocks, but from 2.5 millimeter openings on the under side of 1¾-inch pipe. The good results of this procedure seem to warrant its further study. Forty volumes of air per volume of sewage were being used at the time of my visit, which is not bad for the extremely concentrated sewage treated, and M. Stroganov believes that by improvements in distribution which he has worked out, this amount of air can be cut to ten volumes of air for one volume of sewage. He hopes shortly to undertake the construction of a

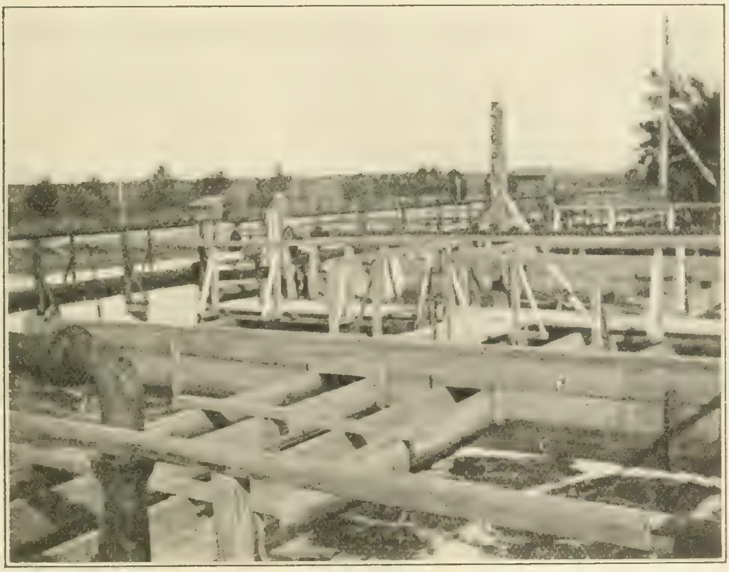

FIG. 11. EXPERIMENTAL ACTIVATED-SLUDGE TANK, MOSCOW SEWAGE FARM.

3,000,000-vedro activated sludge plant which will release the irrigation area or a considerable portion of it for use as a municipal dairy farm. It was flattering to find that M. Stroganov was thoroughly familiar with American sanitary literature and had all our reports and textbooks upon his desk; and it was interesting to note how closely the general conclusions of Russian experts in regard to water and sewage problems agree with those which we are reaching in America. A fuller knowledge and closer coöperation between the two countries in the future will surely be fruitful for both and for the general cause of human progress toward which all our labors tend.

THE OPPORTUNITIES FOR SAFETY ENGINEERING IN CONSTRUCTION WORK.

By David Van Schaack, President National Safety Council.

Mr. President and Gentlemen:

I am always warmly appreciative of an opportunity to talk about accident prevention at a meeting of representative men, whether of one or another of the great branches of industry or of one or another of the professions, but I am especially glad to have this opportunity of speaking to the civil engineers of Connecticut.

A civil engineer is perhaps the best qualified of all engineers to be a safety engineer as well, because in his work he has constantly in mind the fundamentals of Safety or Strength, Utility and Economy, which are also the fundamentals of safety engineering. In planning his work an engineer gives close attention to the methods used in its construction, and he must often consider the safety of the workmen as well as the operations to be performed, because he knows that he cannot get good construction unless the men can work in comparative safety. Every workman devotes some part of his time and attention to protecting himself against injury. The less required for this purpose, the more there is for productive work. So a civil engineer is in fact a safety engineer without, perhaps, realizing it.

It is no exaggeration to say that within the past few years there has grown up a new branch of the engineering profession—that of safety engineering—which has already a well-defined field of usefulness in present day industries. It owes its origin to the rapid increase of organized safety work in manufacturing plants and other industrial operations, an increase which is notably evidenced by the National Safety Council's growth within five years from forty members to a membership of 3,500 industrial concerns, employing upward of 6,000,000 workmen. Many concerns now employ safety engineers to devote their entire time to a thoroughly organized safety campaign, comprising the two essentials of accident prevention work, safeguarding and the education of the workmen.

The safety movement is now well beyond the experimental stage. Its value is an established fact, and it has gained such impetus that not only can there be no retrogression but failure to continue a rapid and steady advance seems impossible. Some concerns have started safety work not fully convinced that it would amount to much, of a mind that it was perhaps a passing fad, but they have soon found it to be good business. It not only produces direct savings and increases the efficiency of workmen, but it promotes the better feeling between employer and employees which is so highly desirable. It has been the history of almost every case that employers who once start an organized safety movement increase each year rather than decrease the amount of time and money given to it. The movement grows, and grows rapidly, as they see the results of their first efforts.

What has been accomplished so widely in manufacturing plants can be done in construction work—in fact has been done, as Mr. von Woedtke will tell you. Perhaps even more can be done in construction work, because a greater need exists. Construction work as a class is one of the most hazardous. Each year it exacts a heavy toll of killed and maimed. The underlying principles of safety work apply to construction the same as to other branches of industry, and there is no doubt about the results of their application being equally satisfactory. Stated as two aphorisms, these principles are as follows:

> A condition of safety should surround all the operations of construction work in so far as the location or the nature of the operation will permit,

and

> Each person should strive to keep from injuring himself or others.

As is plainly seen, the first places responsibility on the owners, the contractors, the engineers, the superintendents and foremen, or others who share as parts of the "directing minds" of the operations. The "Hand of God" causes very few accidents. They are generally the result of somebody "taking a chance" who knew better.

The second, that "each person engaged in construction work should strive to keep from injuring himself or others" is something to be instilled into the minds of the workers. It is useless, of course, to provide good equipment if it will not be used, or give instructions for safe methods if they will not be carried out. The desire for safety must be in the minds of the foremen and workers, themselves. At first thought, it might appear as an almost hopeless task to instill into the minds of some workmen a sense of carefulness about themselves or others. But I want to say right here that such is not the case. The old copy book adage of "Self preservation is the first law of nature" is still a moving impulse, and most workmen can be brought to note the advantages to themselves of safe equipment and safe methods. The greatest difficulty, perhaps, is with the quick, heedless type of worker who delights in scorning danger in order to "show off." This kinds needs to be disciplined as well as educated. Some rules are necessary at times, but I believe the fewer the rules the better. "Verboten" had best be left in Germany, where it belongs, and where they seem to take more kindly to it than they do in this country.

Safety work in construction is, therefore, as in other industrial fields, dependent on safe methods and equipment and on education. The importance of the first two have long been recognized, while that of education has only within recent years come to be appreciated as it should. Each is dependent on the others for anything like complete fulfillment of its purpose. All are dependent upon that cordial coöperation between employer and employees which is obtainable only through organization, and this coöperation cannot well be expected from the workmen unless they have reason to believe that their employer is willing to do his full share in the joint effort which will inure to their common benefit. What and how the employer does in taking care of his part are the best tangible evidence of his good faith.

You, as engineers, readily appreciate that accident prevention is an economic necessity. The strenuous business competition of to-day calls for the highest degree of efficiency if success is to be attained, and industrial accidents are such an actual and potential cause of impairment of efficiency that they cannot be ignored.

Without belittling its humanitarian side, the day has gone by when safety work was considered an humanitarian fad; the experience of employers who have undertaken it proves too plainly that it is good business. Gone by, too, is the day when its economic value was measured solely in terms of damages or compensation saved, or lessened insurance cost. Considerable as the direct cost of accidents may be, they are much more expensive to an employer through the lost time of injured men, through interruption of the work of others caused by accidents, through the waste of material and the spoiling of product by new men, through their lessened production, through the time of foremen or others diverted for their training.

Not only does safety work cut down the loss in efficiency due to accidents, but it tends to increase output. The less time a workman has to devote to avoiding injury, the more he has to give to production. And the spirit of coöperation among workmen developed by organized safety efforts is also plainly reflected in a greater interest in their work.

Every employer knows how costly labor turnover is, how important it is to the general efficiency of his plant to keep his labor force as intact as possible. Especially is this appreciated now, when the turnover is so phenomenally large. Safety work reduces labor turnover, both directly through lessening the number of employees killed and injured and indirectly through promoting better relations between employer and employed.

The thinking employer, who takes carefully into account every single item of cost entering into the turning out of his product and who endeavors in every way to conserve his capital investment, must view with favor anything which tends to stabilize his working force. With the necessary money available, it is possible to purchase his equipment in a short time, but the creation of an efficient working force often requires years. No matter how carefully the original material is selected, it has to be readjusted, sifted out, replenished, sifted and replenished again and again, before the desired efficiency is reached. All this takes both time and real money, plenty of it. Once created, an efficient working force is not only a most valuable asset, but it represents a capital investment which is well worth all the protection that can be given it.

One of the pioneers in safety work struck the keynote when he said that the best safety device was a safe man. Another has put it that the greatest factor operating toward the prevention of accidents is not the prevention device, but the "prevention spirit." The safety slogan which has the strongest appeal to me is "get the safety habit." There is a lot of meaning in that phrase. Safety habit is but another way of spelling caution, which is the one and only preventative of so large a number of industrial accidents. The safety habit may, perhaps, not be so easy to acquire as some other habits of which we know, but it is certainly much more worth while.

I do not think I exaggerate in making the statement that promoting the safety habit, getting the men to think safety and to think it unconsciously, is the biggest thing that safety engineers have to do, and the most difficult. It is the leading feature of the general educational work which is the keynote of all successful accident prevention campaigns. Workmen do not intentionally get hurt, but ignorance and thoughtlessness are the most prolific causes of accidents, and these causes can be eliminated only through a comprehensive plan of education.

It has often been said that recklessness and carelessness are among our national characteristics. I prefer to believe that it is the American workman's fine sense of independence that leads him instinctively to pass his own judgment upon matters affecting his safety as well as all other matters. He must, therefore, be educated so that his judgment will be correct. He must be made to see that risks actually do exist, that he as well as others is subject to them, and that he must habitually exercise caution if he is to avoid their consequences.

He must be brought into such a state of mind that when the time comes for taking the dangerous chance he will instinctively visualize the accident which may result if he takes it. His imagination must be developed and pointed in the right direction. It is curious how many workmen seem unable to picture themselves in the place of a man injured. It is curious, too, how many will appreciate one danger and fail to see another, even one correlated.

That blind confidence in the record of the past, so generally present, must be overcome—that feeling that because nothing has happened while the work was done in the good old way, nothing ever will happen. So, too, must the frequently held belief that the introduction of safe methods is a reflection upon the workman's ability to take care of himself. Workmen are just like the rest of us. Through long usage, they fall into confirmed habits and are resentful of innovations.

The one thing to do is to create an atmosphere of safety, if I may so describe it, and the more the foremen and workers participate in creating it, the better the results will be. The size of the job in no way governs the degree of safety that can or should be attained. The underlying principles are just as much needed and are as effective on small work as on large work. Suggestion, education and persuasion will obviate much of the need for coercive measures.

Especially should the foreman be in full sympathy. Not only is his the closest authority, but he is the natural teacher of the men and the example whom they emulate. The foreman often makes the best rule book and danger signal. If you can interest him, help him to see clearly the causes and remedies of accidents, if you can make him feel that accident prevention is worth while, I venture to say that three-quarters of the work is accomplished. He is in the best position to note the real hazards of the work and determine the true causes of accidents. He is closest to the men and his influence to induce them to acquire safety habits can be enormous.

There is another feature of accident prevention, and a very important one, to which I should like to call your attention. This concerns itself with the selection of men for work and their instruction in it. Too little attention, from the safety standpoint, is often given to these matters. To put a heavy, slow-thinking man on a job requiring both bodily agility and mental alertness, or vice versa, is simply inviting accident. So, too, is assigning a man to work without carefully instructing him how to perform his duties safely as well as otherwise efficiently. Every new man on a job should be carefully instructed in general safety as well as in the safe way of doing his particular work.

The conservation of man-power in industry is not merely a matter of selfish concern to industry. Upon it depends in large part our success in the war which we are waging for our own liberty and the freedom of mankind. Back of every man in the trenches must stand five men in the shop and in the field, and it is the privilege and the duty of industry to keep them there. That we cannot all go to the front does not mean that we cannot take an active part in the war. Whether as individuals or as captains of industry, we are called upon to do our best. This is a war of peoples as well as armies, and every effort of conservation as well as production must be put forth. We must produce more than ever, and with less men at our disposal, both to win the war and to offset, in the only way possible, the war's tremendous drain upon our national wealth. We must conserve more than ever, so as to meet the better the new problems of the future.

For the first time in the history of the world, the days of reconstruction will suffer an universal shortage of able-bodied men, a fact which will greatly influence the relations of employer and employee, if it does not reverse their relative positions. A new conception of society, too, seems sure to prevail in the years to come.

The tremendous upheaval which the world is now undergoing cannot be restricted in its ultimate effects to readjustments of national boundaries and to racial groupings of peoples, not even to a determination of the question of whether the world shall be safe for democracy, as we have hitherto understood democracy to mean. The whole structure of society is being shaken to its very foundations, and when armed strike ceases and the time for rebuilding comes the work must proceed in the light of a new understanding of the relations of man to man.

Before closing I wish to say a few words about the National Safety Council. As I have already said, the Council has had a phenomenal growth during the five years of its existence, numbering among its members now about 3,500 concerns, employing upward of 6,000,000 workmen, the location of which extends well throughout the United States. The membership dues vary in the case of all industries except railroads according to the number of men employed, ranging from $15.00 for a concern employing within 100 members, to $150.00 for a concern employing upward of 10,000 members.

It furnishes a direct service in several ways to its members. Its bulletins, which are mailed out weekly, number 250 in the course of a year. Most of these bulletins are for display on bulletin boards, but a number of them are service bulletins designed to keep the employers acquainted with the latest developments in safety work. It also publishes safe practices leaflets. It organizes members living in a vicinity into Local Councils which engage in local activities of all kinds. Its members are also organized into sections for the purpose of dealing with the peculiar hazards of particular industries. Bulletins are also published for these sections. Various other information is conveyed to the members from time to time, and the library and information bureau of the Council at its Chicago headquarters is always at the disposal of members desiring to ask any particular questions. The Council's aim is to act as a central clearing house of information and experience in accident prevention and allied matters, and at its central office it has a competent staff constantly engaged in promoting its work. Each $7.50 of membership dues paid by any member entitles him to a complete set of the Council's mail service. The Council also holds Annual Congresses where both general and sectional sessions are held and which are attended by many hundreds of men. It is planned to include a construction sectional meeting in the program of the next convention, which will be held at St. Louis next Fall, and on behalf of the Council I ask your interest and assistance in this work.

THE NEW HAVEN SEWAGE EXPERIMENT STATION.

F. W. Mohlman and W. S. Sturges, Jr.

In 1917 New Haven took a long-contemplated step, in establishing a Sewage Experiment Station, for the purpose of investigating various processes for the treatment of the sewage of the city prior to its discharge into the harbor. This action was recommended to the city by the United States Public Health Service, which had conducted a survey of the sanitary condition of the harbor in 1916. Their recommendations were concurred in by Prof. C.-E. A. Winslow and Prof. S. E. Barney of Yale University, who offered their services to the city free of charge. The City Council accepted their offer, and appointed a citizens' committee to supervise the work. The plant was designed by Professor Barney and Mr. R. H. Skelton, and its operation has been directed by Professor Winslow. The authors of this paper are, respectively, chemist and engineer-in-charge, and bacteriologist. Mr. Harold G. Wynne of the City Engineer's office has assisted in the engineering work at the plant since January 1, 1918.

PRELIMINARY CONSIDERATIONS.

The sewerage of New Haven is on the combined system. The sewage is discharged into the harbor through six outlets, all partially submerged at high tide. The depth of dry-weather flow in each sewer was measured during August, 1916, by the City Engineer's office, and discharges computed, as given below, by the office of Albert B. Hill, Consulting Engineer, New Haven, Conn.

TABLE I.—DISCHARGES OF SEWER OUTLETS.

Sewer	Diameter outlet, inches	Discharge, gallons per day
Sea Street	78	3,632,000
Meadow Street	74	1,738,000
State Street	66	511,000
East Street	63	13,598,000
James Street	45	2,449,000
Poplar Street	54	847,000
Total		22,775,000

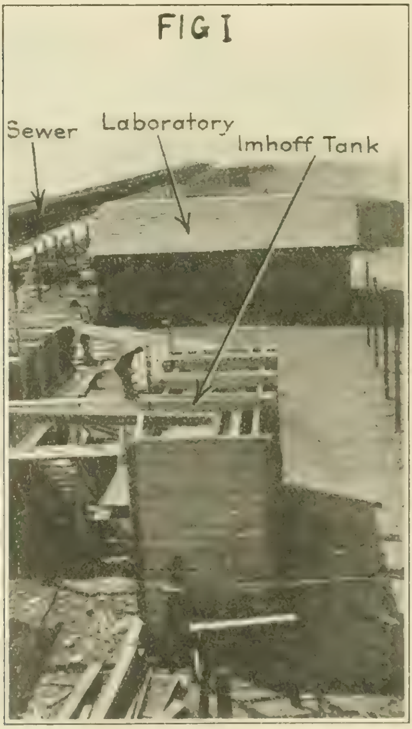

FIG. 1. SEWAGE EXPERIMENT STATION.

The continuous discharge of this volume of sewage has had a pronounced effect on the harbor waters. In the survey conducted by the United States Public Health Service in 1916, under Dr. H. S. Cumming, it was found that the inner harbor was grossly polluted by feces and other floating matter, and that the dissolved oxygen was very low in the summer time. The tidal prism should give an approximate dilution of 300, according to an estimate made by Mr. Henry Kellogg, in charge of the Sewer Department of the Bureau of Engineering.

In view of the fact that the sewage receives such ample dilution within a few hours, it was decided that it was not necessary to obtain a completely stable effluent from the chosen type of sewage-treatment plant. Partial clarification, removal of 80–90 per cent. of the settleable solids, and disinfection are required, and only processes for giving these results are being studied. The oxidation of the residual organic matter in the effluent may be left to the oxygen in the diluting water in the harbor for several decades, although a stable effluent may ultimately be demanded.

New Haven has such varied industries which discharge wastes into the sewers that it was difficult to decide upon the location of the Experiment Station. The East Street sewer carries more than half the total sewage of the city, and in this sewage are wastes from Winchesters' and Marlin's munition factories, from the New Haven Clock Co., the Candee Rubber Co., and part of the wastes from the Sargent Hardware Co. Since this sewage might contain substances which would interfere with biological processes, such as the activated-sludge process, it was decided to build the Experiment Station at the outlet of this sewer. (Fig. I.)

DESCRIPTION OF THE PLANT.

In most of the sewage-testing stations in this country the sewage has been pumped by means of a centrifugal pump, which does not get the surface sewage, containing floating matter and grease, and which breaks up the suspended solids. In our experiments it was very essential that a representative sample of the sewage be obtained, so it was decided to pump it by means of a bucket-elevator. This bucket-elevator was erected in a concrete forebay at one side of the sewer. (Fig. II.) The sewage is deflected into the forebay by a galvanized-iron deflector built out nearly to the center-line of the sewer, and flows back into the sewer at the lower end of the forebay. The elevator is driven by a gear and pinion, which are belt-driven by a five-horsepower motor at the base of the structure. The buckets are submerged to within three inches of the bottom of the forebay, and rise vertically through the current of sewage. Each bucket holds 2.6 gallons, and about 20 per cent. is lost by splashing, so that 2.1 gallons per bucket are delivered. The buckets discharge at the rate of fifty-five per minute, giving a total discharge of 116 gallons per minute, or 165,000 gallons per day. The sewage is lifted eighteen feet and discharged into a hopper-shaped receptacle. From this it flows over to the Station by gravity through a wooden flume six inches square, supported by wooden bents. Before flowing into the weir-box, where it is measured, the sewage passes through a grit-chamber fifteen feet long, twelve inches deep at the inlet end, four inches deep at the outlet end,

FIG. II

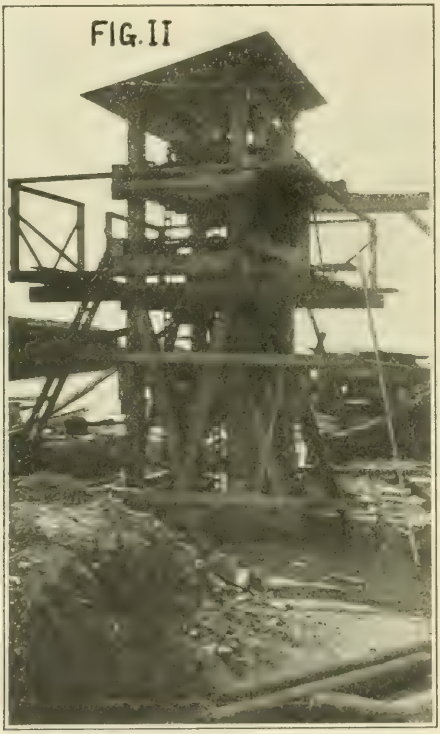

FIG. II. BUCKET ELEVATOR.

and four inches wide, with a detention period of 0.24 minute. The velocity of the sewage is checked to seven-tenths of a foot per second at the inlet end, increasing to two and one-tenth feet per second at the outlet end. This velocity is so high and the detention period so short that very little grit has been removed from the sewage. Supplementary grit-chambers have been placed before the activated-sludge and Miles-acid tanks.

Following the grit-chamber there is a butterfly-valve in the flume, which is automatically controlled by a float in the weir-box. This float operates a needle-valve which controls the flow of city water to a small brass cylinder. A piston in this cylinder is attached to the butterfly-valve in the flume. As the sewage rises in the weir-box it opens the needle-valve, allowing water to flow to the cylinder, pushing out the piston and closing the butterfly-valve. This causes the float to sink, releasing the water and allowing the butterfly-valve to open. This regulator keeps the head constant within one-sixteenth of an inch. It was constructed by Wallace & Tiernan of New York City.

From the weir-box the sewage flows to the various tanks (Fig. II) over adjustable weirs, small amounts of 10,000 gallons per day being measured by 60° V-notch weirs, a larger amount, 100,000 gallons per day, by a rectangular weir seven and one-half inches long. The weirs have been calibrated by volumetric tests.

PROCESS UNDER INVESTIGATION.

The processes being studied are: (1) Activated-sludge, (2) Imhoff, (3) Screening, (4) Miles-acid, (5) Disinfection by liquid chlorine.

(1) The activated-sludge experiments are on the continuous-flow basis. The aerating tank is of wood, sixteen feet long, four feet wide, and eight feet deep. At the bottom of the tank the sides slope at an angle of forty-five degrees to a trough one foot wide, which runs the full length of the tank. An iron frame, in which are cemented fifteen filtros plates, is cemented into this trough. The air is admitted to the inlet end of the trough, and the water which filters through can be drawn off at the outlet end. The air is compressed to three and five-tenths pounds pressure by a Nash hydro-turbine having a capacity of twenty cubic feet of free air per minute. It is measured by means of a Venturi tube.

The settling tank is four feet by four feet in plan, and twelve feet deep to the bottom of the hopper. The hopper slopes at sixty degrees to a sump, in which is cemented a three-inch ell connected to the suction of an air-lift pump. Sludge is pumped back to the aerating tank, where it is measured in an orifice-box. A baffle seven and five-tenths feet deep extends across the center of the settling tank. The capacity of the aerating tank is 3,100 gallons; the settling tank, 1,150 gallons. When treating 17,000 gallons of sewage per day, with fifty per cent. as much sludge returned, the aeration period is three hours, the settling period sixty-six minutes.

(2) The Imhoff tank is of wood, sixteen feet long by four feet six inches wide, by eleven feet six inches deep. The flowing-through chamber extends the full length of the tank, with gas vents eight inches wide on each side. Its capacity is 840 gallons, giving a detention period of two hours, when treating 10,000 gallons of sewage per day. The sludge compartment is several times as large as the flowing-through chamber. The bottom of the tank slopes at forty-five degrees, and great difficulty was encountered in making a water-tight joint at this place. The pressure of the sewage when the tank was full forced the bottom planks apart, and as soon as the sewage reached a certain level it ran out as fast as it ran in. Extra heavy braces were placed under the tank, one layer of canvas and three of tar paper placed inside it, and tie-rods run through it at eight places, in attempting to make it tight. It was finally placed in operation in November, although from 2–5 per cent. of the sewage has been lost continuously, and very little sludge has accumulated.

(3) Screening experiments were planned with the expectation that an experimental Riensch-Wurl screen could be obtained, which was to be operated at the rate of 100,000 gallons per day. In view of the impossibility of obtaining this screen, experiments with a mechanically-operated screen had to be abandoned. Fixed screens of thirty-mesh monel-metal wire cloth, and perforated metal plates similar to Riensch-Wurl plates were constructed, two feet wide by three feet long. These screens are placed in a screen-chamber at an angle of forty-five degrees, and sewage is applied to them at the rate of 100,000 gallons per day. The loss of head is allowed to reach two feet, when another screen is

placed in the chamber, and the first one removed. The screenings are weighed, removed, and the moisture content determined. The effluent is sampled frequently during screening and the suspended solids in the composite sample determined. Knowing the quantity of sewage screened and the weight of the dry screenings, the removal of suspended matter can be calculated. This method of determining removal of suspended matter is more reliable than that which comprises analyses of the sewage before and after screening, since the coarser suspended matters, such as feces, fruit skins and paper are usually not collected in the sample of raw sewage, and thus the screen is not credited with the removal of this material.

(4) The Miles tank is of wood, sixteen feet long, three feet six inches wide, and four feet deep, having a capacity of 1,680 gallons. When treating 10,000 gallons of sewage per day the theoretical detention period is four hours.

This process has been invented recently, and as but little has been written concerning it, a brief description of it may be required. It is patented by Mr. George W. Miles, a consulting chemist of Boston, Mass., and has only been investigated on an experimental scale. Experiments were conducted at Boston in 1915 by Mr. Robert Spurr Weston,* and his results confirm earlier work of Mr. E. S. Dorr, Engineer in the Public Works Department of the City of Boston. The theory of the process is as follows:

Sewage contains a relatively large amount of lime and magnesium soaps, insoluble compounds of calcium and magnesium with palmitic, stearic, and other fatty acids. These lime soaps are not soluble in gasoline or naphtha and cannot be extracted from the sludge by these solvents. If, however, the sewage is treated with a mineral acid, the free fatty acids are liberated from the soaps, and precipitated with the sludge, from which they can be extracted by naphtha. Mr. Miles proposes using sulphur dioxide as the precipitating agent, preparing it by burning sulphur or pyrites, and dissolving the gas in the sewage to form sulphurous acid. This is a well-known disinfectant which is quite toxic to most of the bacteria in sewage. Other advantages of the process are lack of odor, dryness of sludge, and efficient clarification of the sewage. The economy of the process is not definitely proven as yet, although Mr. Weston obtained an apparent profit of $6 per million gallons in his experiments on Boston sewage under pre-war conditions. His figures will probably be revised in the light of more recent knowledge.

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* Jour. Am Pub. H. Ass., April, 1916. Eng. News, 75, 913, May 11, 1916.

The process has very recently been investigated by the Massachusetts State Board of Health, and their report is found in the current issue of Engineering News-Record (Feb. 14, 1918). They used small-scale bottle experiments and eighteen hours' sedimentation, and compared the results of the acid process with plain sedimentation on this basis. They considered the difference in results not worth the extra cost.

In our experiments sulphur dioxide in cylinders has been applied to 10,000 gallons of sewage per day in such amount as to keep the effluent acid practically all of the time. The gas is mixed with the sewage in a two-inch pipe, eighteen feet long, and is completely dissolved as the sewage enters the settling tank. Sewage is passed through the tank continuously for from four to seven weeks, after which operation is discontinued, the supernatant liquid withdrawn and the sludge measured, weighed, sampled and analyzed.

(5) Liquid chlorine is applied to effluents from the Imhoff tank, activated-sludge tank and screening chamber by means of a Wallace & Tiernan solution-feed apparatus, designed for these experiments with three solution jars and volumetric meters. The chlorinated effluents run through baffled tanks in which the detention periods are from two to five minutes. Samples are plated after thirty minutes' storage.

CHARACTER OF THE RAW SEWAGE.

As might be expected from the nature and quantity of wastes discharged into the sewer by the factories mentioned previously, the character of the sewage is quite different from that of a typical domestic sewage. On May 7–8, 1917, twenty-four samples were collected, one each hour, and a complete analysis made of each sample.

TABLE II.—ANALYSES OF SAMPLES OF RAW SEWAGE COLLECTED HOURLY.
MAY 7–8, 1917.

	PARTS PER MILLION									
			NITROGEN				SOLIDS			
Time	Chlorine	Alkalinity	As NH_3	Total Organic	NO_2+NO_3	O Consumed	Suspended	Total	Bacteria per cc. 20° C.	Gas Formers per cc. 37° C.
8 A. M.	2075	76	10.4	17.6	3.8	50	165	4430	4,200	100
9	2750	94	7.6	14.0	2.6	49	445	6178	.....	.....
10	2725	70	6.0	11.0	2.4	50	230	5880	4,500	100
11	2875	90	4.0	13.6	2.4	50	122	5057	.....	.....
12	2775	104	4.2	12.6	2.5	51	133	5872	70,000	1,000
1 P. M.	2675	98	4.0	13.6	2.2	50	189	5440	.....	.....
2	2675	66	3.4	11.0	2.5	45	155	4313	97,000	1,000
3	2100	72	3.2	10.4	3.2	51	107	5583	.....	.....
4	1600	80	3.6	10.8	3.8	42	87	3325	33,000	1,000
5	1350	48	3.4	11.0	3.2	37	97	2840	.....	.....
6	100	56	4.8	12.8	2.4	48	126	540	25,000	1,000
7	47	108	4.2	13.4	1.4	52	90	433	.....	.....
8	38	72	4.6	15.4	1.3	50	97	342	.....	.....
9	36	80	5.8	10.2	1.2	49	80	312	.....	.....
10	37	72	5.4	9.0	1.6	35	65	262	.....	10,000
11	32	70	5.6	9.4	1.1	33	47	230	.....	.....
12	29	64	4.8	7.2	1.0	22	42	170	.....	10,000
1 A. M.	23	56	3.2	5.6	1.1	15	21	108	.....	.....
2	21	48	2.0	5.2	1.0	14	18	115	.....	1,000
3	17	46	1.8	3.0	1.3	15	9	93	.....	.....
4	14	42	1.6	2.4	1.2	9	14	92	150,000	10,000
5	17	42	2.0	3.6	1.4	15	17	122	.....	.....
6	20	56	3.6	10.0	1.3	24	42	182	51,000	100,000
7	1350	68	5.4	17.0	1.2	34	87	2655	362,000	10,000
Average	1058	70	4.4	10.4	2.0	37	104	2275	88,500	12,100

The results of analysis indicate that some trade-waste containing large amounts of chlorides is discharged into the sewer from 7 A. M. to 6 P. M. The nitrogen determinations show that the sewage is very fresh, the ratio *Ammonia-nitrogen : Total-organic-nitrogen* being unusually low. The presence of large amounts of nitrite and nitrate nitrogen also testifies to the freshness of the sewage. The alkalinity, oxygen consumed and suspended solids are unusually low. The dilute character of the sewage is due largely to the excessive consumption of water in New Haven, amounting approximately to 180 gallons per capita per day.

The most unusual features of the analyses are the large amounts of chlorides and total solids, and the low bacterial content during the daytime. During the week of July 9–16, 1917, samples collected at the plant during the daytime had the bacterial content indicated in Table III.

TABLE III.—BACTERIAL CONTENT OF SEWAGE, WEEK JULY 9–16.

	Total Count, Agar, 20° C.				Gas Formers, 37° C.			
Day	8 A. M.	10 A. M.	1 P. M.	4 P. M.	8 A. M.	10 A. M.	1 P. M.	4 P. M.
Mon.	1,500,000	225,000	59,000	16,000	100,000	1,000	1,000	100
Tues.	1,080,000	128,000	5,000	7,500	100,000	100	1,000	100
Wed.	1,670,000	81,000	7,000	100,000	100,000	100	100	1,000
Thurs.	1,100,000	148,000	1,500	12,000	100,000	10,000	100	10
Fri.	1,125,000	42,000	9,000	9,000	100,000	100	100	100
Sat.	....	68,500	7,100	800,000*	......	100	10	100,000*
Average ...	1,295,000	115,400	14,700	159,000	100,000	1,900	385	17,000
Sun.	....	3,355,000	2,275,000	2,535,000	......	100,000	100,000	100,000

These results clearly show the presence of some disinfecting substance in the weekday sewage. Although the sewage is found to be acid at times, the composite samples are rarely acid, and it is believed that none of the above samples were acid. Samples were collected from the source of the sewer to its mouth in order to trace the disinfectant and the high chlorides. Table IV shows how exactly they were located.

TABLE IV.—SOURCE OF COPPER AND CHLORIDES IN NEW HAVEN SEWAGE.

		Parts Per Million				Gas
Description of Sample	No.	Alkalinity	Chlorine	Copper	Bacteria per cc. 20° C.	Formers per cc. 37° C.
Near source of sewer	1	54	67	0.0	990,000	100,000
Below munitions factory ..	2	90	144	8.8	3,000	100
" " " ..	3	165	74	5.6	3,000	1,000
Small branch sewer	4	134	72	0.0	559,000	10,000
Main sewer	5	...	...	...	70,000	100
" "	6	150	71	1.9	380,000	10,000
Below rubber factory	7	90	2700	3.5	65,000	1,000
Experiment Station	8	130	2500	...	53,000	1,000

The high chlorides enter the sewer between Stations 6 and 7. Inquiry showed that a large rubber factory in this vicinity was pumping 2,000 gallons per minute of sea-water for condenser purposes, all of which was discharged into the sewer. This serves to keep the sewage fresh and alkaline as it is discharged into the harbor.

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* Factories shut down at noon Saturday.

The presence of copper in the sewage was suspected from qualitative tests. The samples were analyzed quantitatively for copper, and that collected at Station 1 contained no copper, while that collected at Station 2 contained eight and eight-tenths parts per million. This undoubtedly accounts for the sudden reduction of bacteria from 990,000 to 3,000 per c. c., and is probably the disinfecting substance present in the sewage. It comes from the waste liquors from the pickling of brass cartridges and cannon shells in sulphuric acid. It is present in the sewage on week days in sufficient amount to prevent septicization of the composite samples of raw sewage, and to reduce the number of bacteria very greatly, as shown previously in Table IV. It has made it impossible to use the methylene blue test for determination of the relative stability of the raw sewage and effluents, except on Sunday.

RESULTS OF OPERATION.

(1) *Activated-Sludge.* The activated-sludge experiments have been carried on continuously since June 1, 1917, but operation has been very unsatisfactory this winter. The distribution of air has become very poor, probably due to the accumulation of ice in the channel in which the filtros plates are cemented, and also to iron rust from this channel, which plugs up the lower surfaces of the plates. If filtros plates are set in iron frames, care should be taken to paint the iron with pitch or some waterproofing material so that it will not rust. The air pressure has risen from seven inches of mercury to eight and one-fourth inches, an increase of six-tenths of a pound.

Since we required only clarification and not nitrification for New Haven sewage, we have attempted to cut down the air to the lowest possible quantity that will give good clarification. We have been at a disadvantage since we have not re-aerated the sludge, and so we have had to apply enough air to keep the sludge in good condition, although this was probably more than would be necessary if we had re-aerated the sludge after sedimentation. The best results we have obtained, over a length of time sufficient to be representative, were from September 1–9. During this period we treated 17,280 gallons of sewage per day, with two and six-tenths hours' aeration and one hour settling periods, using one and five-tenths cubic feet of air per gallon of sewage, and with 11 per cent. of sludge in the aeration chamber. We obtained the following average results:

TABLE V.—RESULTS, ACTIVATED-SLUDGE TANK, SEPTEMBER 1–9, 1917.

	Suspended solids P. P. M.	Volatile suspended solids	Settleable solids cc. per 1.	Bacteria 20° C. Per cubic cent.	Gas formers, 37° C. Per c. c.
Raw sewage	81	55	2.25	607,000	33,000
Activated-sludge effluent	23	15	0.15	199,000	3,500
Per cent. reduction	71	73	93	67	89

In general the reduction of suspended solids has not been over 60 per cent, even with two cubic feet of air per gallon of sewage this winter. The effluent will require at least three parts per million of chlorine to be of the quality we have set as our standard, namely, 10,000 or less bacteria and 100 or less gas formers per cubic centimeter.

Analyses of the sludge show that it is of very poor quality when considered as a fertilizer.

TABLE VI.—ANALYSES OF ACTIVATED SLUDGE.

		Dry basis		
Date	Moisture	Volatile matter	Nitrogen	Ether extract
June 16, 1917	94.4	43	2.89	5.2
June 23, 1917	94.0	42	3.05	5.4
Sept. 25, 1917	94.2	50	3.45	...
Nov. 15, 1917	94.8	53	3.51	...
Average	94.3	47	3.23	5.3

We have come to the conclusion that this sewage is not well adapted to treatment by activated sludge. The acids and copper in the sewage have certainly interfered with the biological conditions demanded by this process, and may have prevented satisfactory clarification. It is probable that our results could be improved by further and more careful experimentation, but with power at least two cents per kilowatt-hour, the cost would be very high, with but little return from the sale of the sludge. We have not been encouraged to go much further with the activated-sludge experiments in view of the results obtained.

(2) The Imhoff tank was put in operation on November 6, 1917. No formation of scum has been noted as yet, and very little sludge has accumulated. As before noted, the tank still leaks slightly, and sludge may be escaping at its bottom. The operating results have been very satisfactory with regard to clarification.

TABLE VII.—RESULTS OF OPERATION, IMHOFF TANK.

	% reduction			Per cubic centimeter			
				Total bacteria, 20° C.		Gas formers, 37° C.	
Month	Suspended solids	Volatile susp. solids	Settleable solids	Influent	Effluent	Influent	Effluent
Nov.	47	41	82	677,000	1,759,000	16,200	13,600
Dec.	47	38	84	170,000	214,500	14,000	15,250
Jan.	45	43	85	73,100	67,700	14,570	2,760
Average ..	46	41	83	306,700	680,400	14,920	10,530

The bacteriological results have been decidedly erratic. More uniform results will doubtless be available after we have had time to gather more data. A limited number of chlorination experiments have indicated that about five parts per million of chlorine will be required to give the desired bacterial reduction.

(3) Screening tests have been intermittent, and have been discontinued this winter due to the inclement weather. Only the thirty-mesh monel-metal screens have been used so far, although plates similar to Riensch-Wurl plates are now ready for use. Only day sewage has been screened, so screening of the sewage for twenty-four hours would certainly give lower results. The average of our results from June 22 to December 7 shows that 15.1 per cent of the suspended solids and 42 per cent of the settleable solids have been removed from the sewage. The wet screenings contain approximately 88 per cent water, and when dry contain 70 per cent volatile matter and 1.96 per cent nitrogen.

Screening has given no consistent reduction either in the total count of bacteria or in the B. coli content of the sewage. It has, however, reduced the chlorine requirement of the effluent. We find that raw sewage requires eight parts per million of chlorine to give the same result as is obtained with six parts after screening.

(4) The Miles acid process has been in operation, discontinuously, since June 1, 1917. Three complete tests have been made, and a fourth is now in progress. The average results of the three tests are shown in Table VIII.

TABLE VIII.—OPERATION, MILES ACID PROCESS.

Average of three tests.

First test, June 2–25, inclusive, 25 days.
Second test, July 5–28, inclusive, 24 days.
Third test, Nov. 6–Dec. 19, inclusive, 44 days.

	Raw	Effluent	% Reduction
Suspended solids	105	43	59
Alkalinity	55	–52 (acid)	....
Bacteria, 20 C.	558,000	8,000	98.5
Gas formers, 37 C.	19,860	160	99.2

Moisture content, wet sludge	86.9%
Wet sludge, pounds per million gallons	3630
Dry sludge, pounds per million gallons	475
Ether extract, dry sludge	25.6%
Ether extract, pounds per million gallons	121
Nitrogen, dry sludge	1.60%

Our experience has been that an average acidity of fifty parts per million (as $CaCO_3$) in the effluent is sufficient to give practically as good results as acidities of 75–100, and we have attempted to keep the effluent at this reaction. Tests of the influent and effluent for acidity are made every hour, and usually it has been possible to regulate the flow of acid to the alkalinity of the sewage. The pressure of the gas in the cylinder varies with the temperature, so that frequent adjustments of the valve are necessary. If the acidity drops to 10–20 there will be an increased amount of settleable solids in the effluent, and the bacterial results will not be satisfactory for our standards.

Averaging our counts for all acid samples of effluent tested, we find 8,000 bacteria and 160 gas formers per cubic centimeter in the effluent, showing a reduction of 98.5 per cent and 99.2 per cent, respectively. The acidity of many of these samples was considerably below fifty parts per million. If the results for these samples of low acidity were discarded we would have even more striking results. On the other hand, the actual reduction is not as great as it would seem since the sulphurous acid exerts a strong disinfectant as well as germicidal action, and does not allow the total number of organisms on the plate to develop in two or three days incubation. This point is being particularly investigated.

The dilute sewage which we have treated has produced a very small amount of sludge, averaging 475 pounds per million gallons. This sludge has contained an average of 87 per cent of water just as taken from the tanks, after being allowed to drain for twenty-four hours. The layer of sludge was only three or four inches thick, and the tank very shallow. We feel reasonably certain that the sludge can be concentrated to 85 per cent water in practice, with deeper tanks and improved methods of draining the sludge. This dryness of the sludge is noteworthy, and is probably due to the de-flocculating effect of the acid on the colloidal suspensoids in the sewage. With sludge of this dryness, it may be economical to apply it to direct-heat dryers without filter-pressing. We have easily concentrated it to 65 per cent moisture in a small centrifuge with a twelve-inch imperforate bowl, but this treatment resulted in segregation of the grease in the liquid flowing away from the machine. Approximately two-thirds of the grease was removed in this way, so it will not be practical to use centrifuges of this type for concentrating the sludge.

The dry sludge has contained an average ether-extract of 25.6 per cent, which would indicate a grease content of 121 pounds per million gallons, but in practice not all of this could be recovered. Gasoline or naphtha would be used as solvents on a practical scale, and these solvents will not remove as much material as will ethyl ether. It is not possible to remove all of the grease, approximately 2 per cent remaining in the sludge. For these reasons probably not more than 100 pounds of grease per million gallons can be recovered from this sewage. It appears that the grease we have recovered from this sewage is of poorer quality than garbage grease, due to the admixture of mineral oil, which probably comes from the cutting-oils used in the machine shops of the city, and we are not prepared at present to make any estimates of its value.

The value of the de-greased tankage as a fertilizer will depend upon the amount of nitrogen and phosphorus in it, and the availability of these elements for plant food. The nitrogen is worth much more than the phosphorus. Our de-greased sludge will probably contain 2.5–3.0 per cent ammonia, but we have not as yet determined the value of this per unit.

Our results indicate that approximately 700 pounds of sulphur dioxide will be required per million gallons of sewage. Sulphur is at present $30 per ton, and one ton will produce two tons of sulphur dioxide. This gives a nominal cost for sulphur alone of $5.25 per million gallons.

At the present time we are investigating such points as have just been mentioned, and we hope to have definite estimates in the near future from the largest producers and consumers of grease and fertilizer in the country. If it can be proven that there are definite values in the recoverable products, which will reduce the present cost of clarification and disinfection, the Miles process deserves serious consideration.

We are also studying other aspects of this process, such as the effect of the effluent on the fish and the dissolved oxygen in the harbor waters. This point has not been considered heretofore in recommending sulphur dioxide as the precipitating agent, but preliminary work indicates that the possibility of the sulphurous acid and bisulphites using dissolved oxygen for their oxidation to sulphuric acid and sulphates must not be overlooked.

Since the quality of the grease recovered seems to vary with the nature of the sewage from which it was recovered, we are planning to conduct some experiments at another sewer outlet, in order that we may recover some grease from a sewage more domestic in character, and compare its quality with that which we now have.

ACID PROCESS VERSUS PLAIN SEDIMENTATION.

There has been a great difference of opinion as to the results obtained by the Miles acid process as compared with plain sedimentation. In order to compare the two processes, we operated the Miles acid tank as a plain sedimentation tank from August 17 to September 27, 1917, using the same quantity of sewage per day, and the same procedure in every way, except the addition of acid. The results of operation are shown in Table IX.

Table IX.—Results of Plain Sedimentation.

One test, August 14–September 27, 41 days.

	Raw sewage Parts per million	Effluent	% Reduction
Suspended solids	88	53	40
Alkalinity	68	88	Increase
Ammonia nitrogen	4.1	6.6	Increase

Moisture content, wet sludge	90.4%
Wet sludge, pounds per million gallons	3135
Dry sludge, pounds per million gallons	301
Ether extract, dry sludge	19.5%
Ether extract, pounds per million gallons	58.7
Nitrogen, dry sludge	1.52%

According to these results, but 40 per cent of the suspended solids were removed from the sewage, as compared with 60 per cent with the Miles acid process. Septic conditions were pronounced in the tank, as the increase in ammonia nitrogen and alkalinity indicate. Bacterial determinations were not made during this test, but there is no doubt but that the count did not decrease to an appreciable extent, considering the condition of the sludge.

The sludge was higher in moisture content than was the Miles sludge, and there was much less sludge and grease recovered. This was partly due to the low suspended solids in the raw sewage, but even if there had been 105 parts, as in the acid tests, instead of 88, the sludge and grease recovered would have been, respectively, 360 and 70 pounds. These quantities are 75 per cent and 58 per cent of the quantities recovered by the acid process. The germicidal action of the sulphurous acid is an important point in favor of the Miles process for our conditions, as disinfection with liquid chlorine is expensive when as much as forty to fifty pounds per million gallons are necessary.

CONCLUSIONS.

In conclusion, we feel that we will soon be able to determine definitely which of these four processes is most suitable for New Haven's needs, and which will be the most economical, considering the results obtained. We hope the work will be followed by the construction of a full-sized plant, so that the gross pollution of the harbor may be lessened, and the sanitary conditions of the bathing beaches and the oyster beds improved.

DERBY BRIDGE.

By R. L. Saunders, Mem. Conn. Soc. C. E., Deputy Highway Commissioner.

By an act of the State Legislature of 1915, all bridges on trunk line routes were placed under control of the Highway Department, with the exception of those within the limits of cities having a population of 10,000 or more.

The passage of this law placed upon the department responsibility for about 130 structures, all more or less in an unsafe condition to carry heavy loads.

The bridge over the Housatonic River between the cities of Derby and Shelton was one of the first selected for attention, owing not alone to its physical condition but also by reason of the fact that at certain hours of the day it was entirely too narrow to accommodate the traffic.

The old structure was composed of four steel spans, totaling about 500 feet in length over all. Each span consisted of a pair of arched plate girders, with hinges at the crown and spring line. Latticed columns rested upon the back of these arches and built-up floor beams ran from column to column at right angles to the axis of the bridge. The roadway was twenty-seven feet in width and carried a single trolley track, south of the center line; two seven-foot sidewalks were cantilevered from the floorbeams.

The piers of granite masonry, about eighteen feet high, were only five feet wide at the top and seven at the base. Analysis showed that practically any uneven distribution of the live load produced tension in the masonry. With one span loaded and the adjacent carrying dead load only, the resultant passed out of the pier within two feet of the top. If the old middle third pressure line theory is any guide, the bridge should have been in the river years ago.

Since the bridge was completed in 1891 it has been strengthened several times to carry the increasing traffic, but the vibration of the piers due to passing loads was so alarming that about two years ago heavy iron rods were put in place, acting as bottom cords tying the ends of the arches together.

In 1916 the condition of the structure was such that it was considered inadvisable to continue its use much longer, and a new design was made to replace it.

The cost of a concrete bridge, including new piers and abutments, with an estimated life of only one hundred years, when compared with that of a steel structure using the old piers and an estimated life of forty years, led us to select the first named. The annual cost for each amounted to practically $11,000, on the assumption above named, and setting aside an annuity earning 4 per cent. But we have no assurance that at the end of forty years a steel bridge could be replaced at the price estimated. If present prices are any guide, twice this amount would be needed.

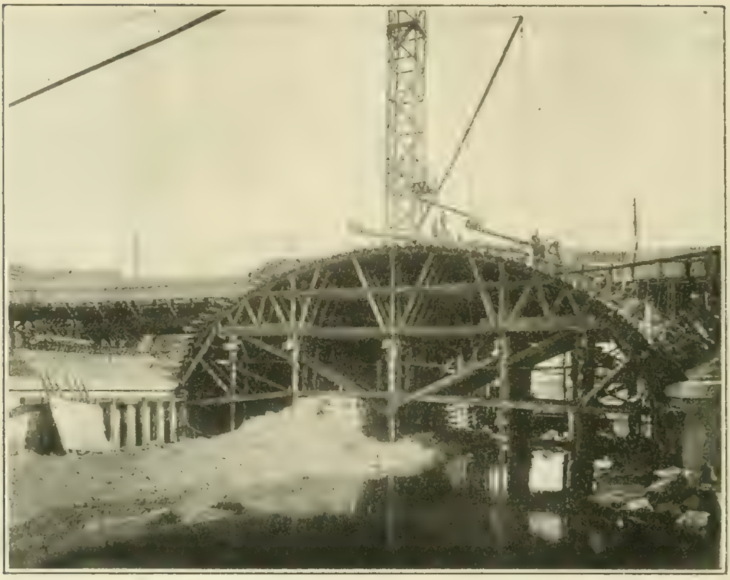
After preliminary study, the earth-filled spandrel arch was selected as being best suited to the location for the following reasons: For appearance, an open spandrel should have a large rise ratio. This would have necessitated either a change in grade at the ends of the bridge, which was out of the question owing to the property damage involved, or placing the spring lines at such a low level that the January freshets, carrying large quantities of ice, would seriously damage the columns supporting the roadway.

This latter condition can be better realized when it is known that less than three-fourths of a mile upstream there is a long dam. Thick ice forms back of this for thousands of feet, and many times a freshet has brought this mass of ice down stream in enormous quantities.

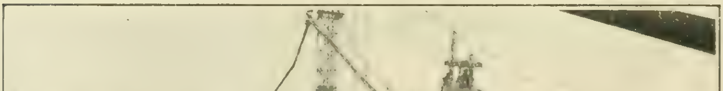
While four arches showed a saving in yardage in concrete, five spans of eighty-five feet each were decided upon, on account of presenting a better appearance, and furthermore an actual saving in cost. This was occasioned by reason of the fact that the location of the piers in the five-span structure did not conflict with those of the old, which were to be left in place to take care of the traffic.

The roadway was made forty-three feet from curb to curb to provide for double trolley track, as provided by law, and two ten-feet sidewalks were added, making the clear width between hand rails sixty-three feet.

The sidewalks, for economy, but not appearance, might better have been cantilevered, but owing to local prejudice the design was made as presented. Since the cost of this change was borne



GENERAL VIEW OF ARCH CENTERS.



ARCHES PARTLY COMPLETE.

entirely by the local communities, it involved no extra expense to the department.

The arch rings, which are three-centered, are two feet thick at the crown and six feet at the springs with thickness increasing but very slightly until near the springs.

One line of one-inch square rods is placed on nine-inch centers, two inches from either face of the concrete. The arch ring was designed to carry the dead load plus two fifty-ton trolleys. This loading, which occurs frequently when trap rock is transported, equals about 300 pounds per square foot, when distributed. The arch is laid out so that the pressure line for full dead and one-half the live load over the whole arch, follows closely the neutral axis, except close to the springs.

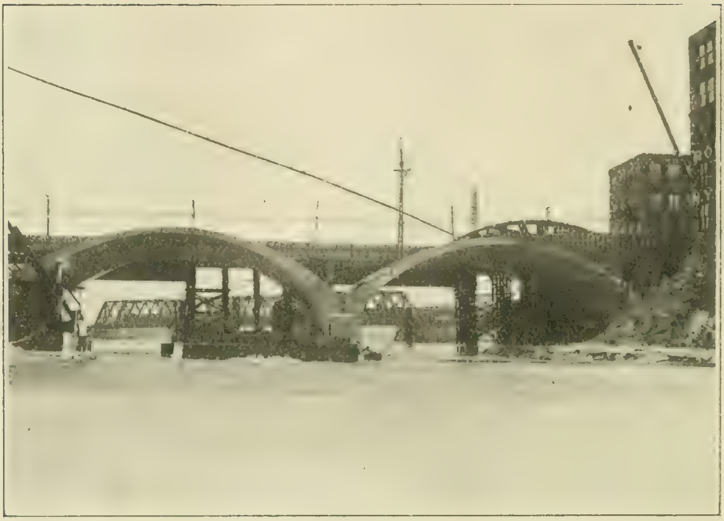
A very slight reduction in the thickness of the arch ring might have been made outside the limits of the trolley area, but since the ratio of the live to dead load was small, any reduction in the live load had but small effect upon the pressure line of the arch ring.

Although all spans are of equal length, eighty-five feet, the rise varies in each with minimum of 21 and maximum of 22.5 feet.

In order to keep the cost of form work down to a minimum, the middle radius was made the same for all spans. The arc subtended by this radius extended to a point about three-fourths the distance from crown to spring line. From this point the curve of the intrados was different for every arch. This design resulted in a material saving in form work, since one set of forms was used for the central portion of all five arches.

The curve of the extrados was made of such radius that from the crown to the haunch there was but slight increase in the rib thickness, thus keeping the temperature thrust down to a low value, about 6,000 pounds for a drop of 60 degrees.

Checking the stresses in the arch ring proved the very interesting fact that, provided the stresses at the crown and springs are safe, it is wholly unnecessary to check the arch at any other points, when all loadings are considered. The maximum concrete compression was under 500 pounds per square inch and the steel approximately fifteen times this amount. The elastic method as outlined by Professor Cain was followed in testing the arch, and in checking, as well as a very excellent shorter method recently developed by V. H. Cochrane of Kansas City.



GENERAL VIEW SHOWING OUTLINE OF ARCHES.

TEMPORARY BRIDGE AND NEW STRUCTURE.

The spandrel walls were designed as cantilevered and at two or three points along the arch-ring buttresses were placed to act as a check upon any initial movement, and to distribute the stresses more uniformly over the arch ring.

Upon top of the spandrel wall a concrete hand rail will be placed approximately three feet six inches high. Posts will be built in at suitable distances and the intermediate space divided into long panels, bush hammered to contrast with the rubbed down sections.

All concrete above the springs is a 1-2-4 mix, using trap rock and sand imported from Long Island, having a tensile strength equal to 120 per cent of Ottawa.

The piers are nine feet six inches wide at the spring line with a batter of one inch in twenty-four. A belting course eighteen inches deep and with an eight-inch overhang was placed just below the springs. The base of each pier was twenty-three feet wide over all, and rests upon the natural soil of the river at a depth of about seven feet below the river bottom. The material encountered at this depth was a coarse gravel and sand mixture, considered capable of holding six to eight tons safely per square foot. Under any probable condition of loading the unit load will not exceed three tons.

Both up and down stream ends of the piers were made round-nosed to eliminate any serious spalling off, due to large ice jams coming down the river. The concrete in all piers and the abutments was made 1-3-5, using local screened gravel and local sand.

The Highway Department's original plan was to leave the old bridge in place, and, by removing one sidewalk, have room to erect one third of the new structure; then, turn the traffic upon this completed one-third and tear down the old bridge.

The contractors, however, considered time could be saved by tearing out the old bridge and building a new one south of the present structure to accommodate the traffic.

Permission was given to do this, and a bridge was erected composed of bents of five piles each, spaced twelve feet center to center; 10 x 10 caps rested upon the piles, and stringers 4 x 14 carried a four-inch plank floor. Under the trolley rails, 10″ x 14″ stringers were placed.

Three openings fifty-five feet in the clear, spanned by old plate girders, were left as relief openings to care for floating ice.

The finished bridge had a roadway nineteen feet in the clear with a trolley on the north side and one seven-foot sidewalk on the south side.

A stiff-leg derrick set up on the floor of the old bridge was used to remove the old steel work, which was first cut with an acetylene torch. The steel arches were left in place till the last and then pulled over with a derrick into the river.

Two lighters, with derricks, operated grab buckets to remove the material from the pier footings. After about half the footing material was excavated, sheet piling was driven and the excavation carried down to the proper elevation inside the coffer-dam.

Wooden sheeting 6″ x 12″ dimension was used on the first two piers, but later Lackawana steel piling was substituted as being better adapted to penetrate the hard footing. In general, it was found advisable to drive the sheeting about three feet below the elevation to be excavated. Between thirty and forty working days were required to complete the excavation in each pier ready for concreting.

The original intention was to place the concrete in the footings after pumping out the coffer-dams, but it was found impractical to drive the sheeting deep enough in the coarse gravel to cut off the head of water.

Accordingly all concrete was placed under water by means of bottom dump buckets. Only enough, however, was placed to counterbalance the external head of water; allowed a sufficient time to set, and then unwatered.

Good results were obtained in every footing except one. At this pier, there was a depth of water inside the dam of about sixteen feet, and a section of base slightly less than seven feet in height was deposited under water. It was known at the time that theoretically the weight of concrete would just about balance the pressure head when the dam was unwatered, but as the concrete was placed directly against the wooden sheeting, it was assumed the friction of the piling in the gravel would hold safe.

However, when the dam was unwatered after a lapse of ten days, the pressure of the water on the under side of the concrete raised the footing and sheeting together, at one corner of the dam, about five inches. To correct this condition grout holes were drilled through the footing in five places, pipes installed and grout forced in under pressure, until there was no reasonable doubt that the footing was in a safe condition. Accurate levels have since been periodically taken on this pier, which at present is supporting two adjacent arches, but absolutely no settlement has taken place to date.

The arch forms were constructed of timber near the site of the work. The total depth of the forms proper reached from the crown to a point about eight feet above the spring line, being supported at this level by piles driven into the bed of the stream.

The centers were built with an additional rise of one and one-half inches to allow for compression at the joints and any settlement in the supports.

Levels taken before and after concreting showed a total deflection at the crown of slightly more than one-half inch before the fill was placed.

A concreting tower was erected close to the middle span and a mixer platform with storage bins built underneath the temporary bridge, through which sand and stone were dumped directly into the hoppers.

The arch ring was concreted in four longitudinal strips, each section constituting a day's run for the mixer.

The average time required to drive the piles, erect forms, place steel and concrete a complete arch was about thirty-seven working days.

At the present time, all piers and abutments are in place, and all arches complete, except that on the end of the bridge adjacent to Derby. One short section of spandrel wall has also been completed.

In the spring, a sand or gravel fill will be deposited on the back of the arches, and when properly settled into place a sheet asphalt pavement on a concrete base will be constructed.

The estimated cost of the structure was $246,000 and the contract awarded to the lowest bidder, the Arthur McMullen Company of New York, for approximately $248,000.

The design was made under the direction of C. J. Bennett, State Highway Commissioner, by the writer, who is also in general charge of construction. E. C. Welden, Division Engineer, has direct supervision of the work, and William Melvin is superintendent for the contractors.

SAFETY ENGINEERING AND ACCIDENT PREVENTION IN GENERAL CONTRACTING

By L. D. von Woedtke, Director of Safety, Fred T. Ley & Co., Inc.

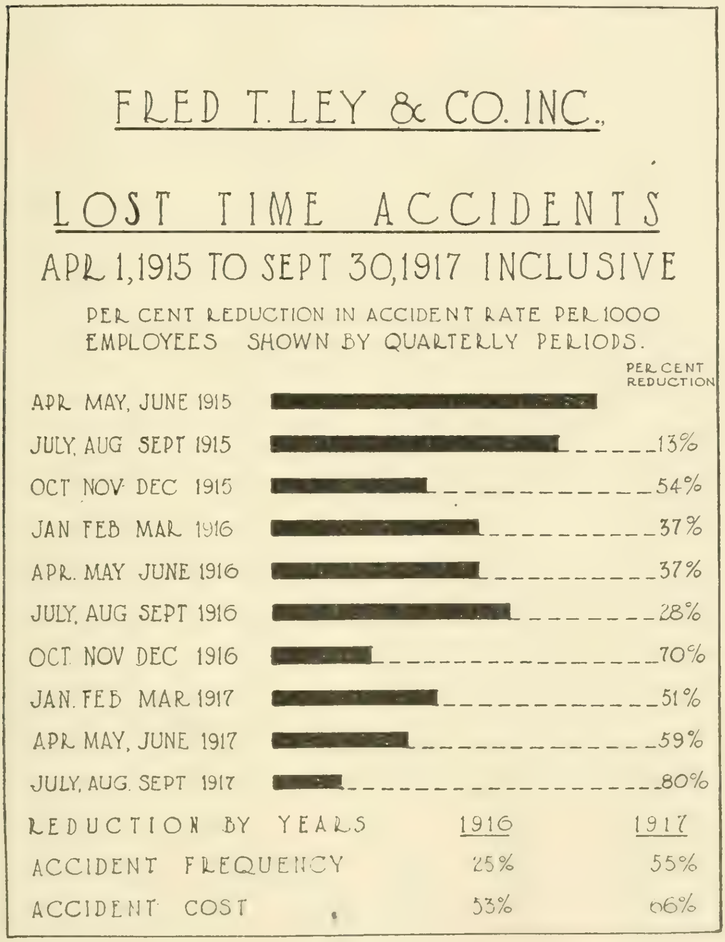
General contracting, in its many branches, is considered as a high hazard. This fact is attested by the high liability rates charged by insurance companies, and by authoritative statistics compiled in every State in the Union, as well as by the United States Government. Yet, in spite of this fact, there seems to be less organized or systematic safety work being done by contractors, as a class, than by almost any other branch of industry. This statement is attested by the fact that the National Safety Council, with its great membership of over 3,500 firms and corporations, employing more than six million workmen, in almost every known line of industry, *only has fifteen building contractors in its entire membership.*

Whether the contractors' attention has not been brought to this condition, or whether they have not considered safety work as an important factor of their business, I do not know, but I sincerely believe that when the average contractor, who is so alert and progressive in every other way, realizes the price he is paying for his inattention to life and limb, efficiency, labor turn over, and increased insurance cost, he will soon line up in the front ranks in the field of safety and lead instead of following in the distance.

I can assure you, and will prove to your satisfaction, that safety work in general contracting does pay, from every possible standpoint, and that instead of being a costly hobby, which slows down production, it actually increases and speeds up production, both in quantity and quality.

The time and money spent in safety work not only comes back, but eventually results in a new form of dividend, heretofore not considered, under profit and loss.

A chart of lost time, accident classification, which I will later throw on the screen, shows comparisons for the last three years, namely 1915, 1916 and 1917. Using 1915, when we started systematic and organized safety work, as a basis, our reduction in accident rate per 1,000 employees for 1916 was 25 per cent, and for 1917 was 55 per cent. The highest quarterly reduction was 80 per cent for July, August and September, 1917.



By way of comparison, the accident cost reduction for 1916 was 53 per cent, and for 1917 was 66 per cent.

I will also throw upon the screen later, our classification chart for the same period, dividing our accidents into eight classifica-

PERCENT REDUCTION IN THE NUMBER OF LOST TIME ACCIDENTS PER THOUSAND EMPLOYEES SHOWN BY YEARS.

Classification of Accidents	1ST YEAR—1915	2D YEAR—1916		3D YEAR—1917	
	No. Accidents per 1000 Employees	No. Accidents per 1000 Employees	Percent Reduction	No. Accidents per 1000 Employees	Percent Reduction
Handling Material........	72	55	24%	33	54%
Falling Material..........	63	35	44%	16	75%
Employees Falling.........	61	43	30%	28	54%
Handling Tools...........	32	28	12%	13	59%
Nails.....................	80	71	11% (Increase)	42	47%
Flying Material...........	12	21	75%	9	25%
Machines..................	24	9	62%	6	75%
Misc......................	55	41	25%	33	40%
Total Average Reduction			25%		55%

tions or causes, as follows: Handling Materials, Falling Materials, Employees Falling, Handling Tools, Nails, Flying Materials, Machines, Miscellaneous.

This chart will show the number of accidents per 1,000 employees and the percentage of reduction for each year on each cause.

For the future, we will add four additional main causes, and when our monthly compilation of this data shows any cause or causes running high in percentage, the same will be subdivided for two or three months to locate the particular occupations requiring special attention.

As you heard my colleague, Mr. V. T. Goggin, lecture with lantern slides, on Camp Devens, yesterday, I might say in passing as to safety work, accident prevention, first aid, etc., at Camp Devens, that we maintained through the entire work a first-class safety engineer, who traveled the job in an automobile, seven days a week, visiting the hundred odd foremen and gangs, both night and day shifts. He made over one hundred recommendations, which were all carried out, and secured the friendly and constant coöperation of every superintendent, foreman and straw boss on the job.

Bulletins, signs and instructions in several languages were posted everywhere, and the total accident rate was probably less than on any cantonment in the country.

The Ley hospital, with its surgeons and physicians, male nurses, adjuster, stenographer, etc., of course, worked in connection with our Safety Department.

The methods we employed at Camp Devens, in this connection, have been put into effect by contractors on several other large Government operations.

Returning to our other operations, not including Camp Devens, I would state that the success in accident prevention, etc., we have attained, is due to a constant and systematic programme of education, and mechanical safeguards, and particularly through the enlistment and maintenance of the coöperation of our superintendents, foremen, timekeepers and men in the field.

We estimate that not over 30 per cent of all our accidents can be eliminated by mechanical safeguards, and that at least 70 per cent must be eliminated through safety education.

Our educational programme consists mainly of periodical letters of encouragement, advice, suggestions and constructive criticism, quoting always some specific types of accidents which are showing a high percentage, and always stating or suggesting specific remedies. In this way, by making a drive against one or two specific causes at a time, we have greatly reduced accidents in all causes, and continually take them up again in turn, for further reduction.

We also encourage suggestions and ideas, and when received, quote them in our general safety letters. Many of our best methods have been secured in this way.

We also use snappy safety slogans, at the foot of all letters sent out by our Safety and Protection Departments, which continually keep the men thinking safety.

Bulletin boards are, of course, posted on all jobs, and fresh bulletins supplied periodically. We usually send out four bulletins at a time, most of which are posted temporarily, until new ones are received; however, some are posted permanently. The job bulletin board is usually three or four feet square, and shows about twelve bulletins at a time. The larger jobs, of course, have more than one bulletin board, so that they may be readily seen by everyone. We consider this bulletin service invaluable, as men will look at striking illustrations, and read large type, well versed and short, who might otherwise never get the "Safety Bug." The foreign laborer will also look at pictures, even though he cannot read the type. Most of these bulletins we secure from the National Safety Council and our insurance companies, but we also make up many of our own. I will show a few typical bulletins on the screen later.

To give you some idea of the possibilities for safety work in general contracting, I will state a few methods we have employed, against each of the eight main causes of accidents which I quoted in the beginning of my talk, and then after showing a few interesting slides on the screen, I will close my remarks.

HANDLING MATERIALS.

1. Proper piling and bracing of supplies of lumber, pipe, brick, cement, etc.

2. Stout, sound runways and platforms of selected materials and proper construction. No make-shifts by workmen allowed.

3. Wheelbarrows, scale boxes, blocks and falls, dump and flat cars, etc., kept in good condition, or discarded if unsafe. Constant inspection made, and employees requested to report all unsafe conditions.

4. Continual cautioning, by foremen, against the "Dropsy" habit.

FALLING MATERIALS.

1. Skirt or toe boards on stagings, scaffolds, and on all exposed edges of floors and elevator shafts, openings, etc.

2. Use of closed-in chutes for rubbish and waste disposal.

3. Daily inspection of all hoisting apparatus, and equipment on the job, and thorough overhauling at main Equipment Plant, when returned from or sent to a job.

4. Tables of safe loads for ropes, chains and cables, also slings, at various angles.

EMPLOYEES FALLING.

1. Railings on pits, staging, scaffolds, and unused sides of floor openings for ladders, etc., and elevator and hoist shafts.

2. Passageways, floors and working spaces kept clear of waste and surplus materials.

3. Good ladders—with safety feet where advisable, or toed, braced or lashed, to prevent slipping.

4. Gates and railings at elevator and hoist shafts, located far enough from openings to prevent anyone leaning over being struck by car or bucket.

HANDLING TOOLS.

1. Tool house and tool men are provided on all jobs, who inspect, repair or sharpen all tools.

2. Plenty of tools provided, allowing one or more sets being repaired or sharpened while others are in use.

3. Heads of all bullpoints, chisels, drills and hammering tools, dressed and trimmed, every time points or edges are sharpened, thus eliminating burred or mushroomed tools.

4. All handles tightened or new handles put on, when they appear unsafe.

NAILS.

1. Water boys, tool men, etc., equipped with hammers, and they constantly bend over or pull out protruding nails.

2. Stripped forms piled clear of passage ways when taken down, and protruding nails piled downward.

3. All loose boards or planks with protruding nails continually picked up, or nails bent over by all men on the job.

FLYING MATERIALS.

1. Goggles are on every job, in every tool box and tool house.

2. Foremen are held responsible for men wearing goggles, when chipping, drilling concrete, stone, steel, etc.

3. Extra sets of chipping or drilling tools provided to allow one or two sets always being repaired or sharpened, while others are in use.

MACHINES.

1. All gearing, revolving projections, keys, set screws, clutch jaws, etc., thoroughly enclosed on mixers, hoisting engines, drums, winches, cranes, steam shovels, saws, etc.

2. Headless set screws, shaft and pulley housing wherever practicable.

3. Adequate grab handles and steps on locomotives, cranes, steam shovels, cabs, dump and flat cars, etc.

4. Correct guards on gauge glasses and water columns.

5. All saws, circular, split, crosscut, overhead or treadle swing, band, etc., equipped with approved safe guards, such as spreaders, blade enclosures, travel limits, table guards, etc.

6. Jointers or buzz plainers provided with cylindrical or safety heads.

7. Pulley blocks equipped with side plates or flanges, to protect mesh point between ropes and blocks.

8. Hooks for large hoists, cranes and derricks, provided with handle on back.

MISCELLANEOUS.

1. Acid carboys equipped with wooden frame inclinators.

2. Electric wires, switches, transformers, etc., protected against personal contact wherever possible by barriers and enclosures, cabinets, etc.
3. Adequate shoring in excavating, or tops kept broken down to prevent cave-ins.
4. Appropriate danger signs, tags, and warnings.
5. Fire prevention—boilers safely housed, smoke stacks fitted with spark guards, salamanders fitted with spark screens. Fire extinguishers provided on all jobs.

There are, of course, many other methods we are using in accident prevention, which time will not permit mentioning.

I shall be glad to take up any of these matters later, with anyone who is interested.

THE CONSTRUCTION OF CAMP DEVENS

By Victor T. Goggin.

I am here this afternoon to tell you something that you all know everything about—the building of buildings—I hope you will be surprised when I get through.

Some few weeks ago I had the pleasure, in Boston, of hearing Congressman McCormick of Illinois, one of the Congressional House Committee, just returned after being abroad all summer studying conditions in Europe at close hand, talk of impressions gained while visiting England, Belgium, France and Italy.

Congressman McCormick had seen these countries before the war and had noted the characteristics of these peoples as only a newspaper man can. This past summer he revisited them and his comments on the changes in their national characteristics were most interesting.

He told us of many wonderful things that he had seen—of many wonderful changes that had taken place in national conditions. In fact, he brought a message that should bring good cheer to all loyal Americans.

As I listened to him talk, it seemed to me that, after all was said and done, he was not telling us anything really new. By that I mean that what he told us was just about what any keen student of history could find by close study of any big event in world history. I mean that where in world history you find a big national event recorded, you generally find a big, great, just cause for it—a cause to defend which a country will go to almost any ends, that where it becomes necessary for near miracles to be performed, a great cause to be upheld, then, somehow or other, these near miracles are performed. That if supermen be needed to perform supertasks—somewhere among the ranks of the people, supermen are recruited to perform them. That if there be needed money down to the last penny; labor to the end of physical endurance, and even beyond; privation to any extent; and sacrifices even unto that of life itself, a country will gladly give that its name be upheld, and its honor remain untarnished. And so to-day we find in Europe that history is but repeating itself.

Here in the United States, with a cause, if anything, more righteous than that of any of the warring powers of Europe, we should find, in after years, recorded on the pages of world history, deeds the like of which have never before been recorded. With natural resources such as ours—national wealth such as ours—national inventive and organization talents such as we possess, and with a government and people solidly behind our President, there is no limit to the things we can do. And already, though we are but a few short months in war, it can be said that we have almost performed miracles.

At the last presidential election some spoke facetiously of Mr. Wilson as the "Schoolmaster President," but to-day, I think, they feel as I feel, that it is well that President Wilson is in command. A lesson has to be taught. Who can do it better than a schoolmaster? President Wilson in this crisis has shown the results of his academic training by preparing his lesson beforehand. He realized, as few of us did realize, that a lesson cannot be taught without much careful study and preparation. That to make it effective all possible sides of the question must be studied and all facts marshalled. And he, therefore, formed what is known as the National Defense Council to assist him with this preparation. This Council was composed of big patriotic Americans giving their services free to the Government.

Their work you are familiar with. They caused a careful survey to be made of every phase of our national existence, and in the end they presented to our President a carefully marshalled array of facts showing him what resources he could call to his aid in administering the lesson he had set out to impress upon the people.

It was early recognized that, if this war was to be won, it would be necessary for us to send armed men to Europe—and that therefore preparations would have to be made to train these men before embarkation.

The National Defense Council, therefore, appointed a subcommittee called the Emergency Construction Committee to take up the matter of the construction of cantonments for this purpose. You will all remember that they divided the country into sixteen great mobilization districts and placed in each a camp capable of holding one full army division of 40,000 men.

It is one of these camps, namely, Camp Devens, at Ayer, that I wish to speak of particularly this evening.

Immediately on the completion of the construction programme by the Emergency Construction Committee, contractors to the number of eleven hundred from all over America patriotically came to Washington to offer their services. Their status was examined, their capacity determined, and selections made.

It was a source of singular gratification to the Fred T. Ley & Co., Inc., to be among the first four firms awarded contracts for cantonments; more so, as Brigadier-General I. W. Littell in informing us of this fact paid us the high compliment of stating that we had been awarded this work after careful consideration, first, because the Government considered we were capable of performing, on schedule, the almost superhuman task demanded of us, and second, because the Government believed its interests were safe in our hands to get a dollar delivered for every dollar paid.

This was on June 13th, and June 15th saw our organization on the site making an inspection. And what they saw was enough to put fear into any engineer's heart.

Consider the site, nothing but rolling land, all knolls covered by scrub oak and a few larger trees, with no water or power facilities, or direct railroad connection.

To appreciate what we had to do you must realize that before September 1st we had to build a modern city to hold 40,000 people under ideal sanitary conditions. That is, we had seventy-seven days, Sundays included, to do it in.

But here we were June 15th, in this wilderness without a thing to start work with. Labor had to be engaged—material purchased and delivered—housing, commissariat and sanitary arrangements made for our men, fire protection attended to, roads built in, the land cleared—and a thousand and one other things attended to before we could get fairly started on our work.

From this small beginning we started on June 26th, thirteen days after being awarded the contract. We had only sixty-four days left, Sundays included.

First, we built an office to house our staff, forty-three feet by three hundred and eight feet—an office sub-divided into twenty-five rooms with one hundred and six branch lines of telephone, necessary toilet facilities, and everything that should be included in a job administration building—which we did in seventeen and one-half hours, and for a water supply we sank a well and erected a tank in three and one half days. While men sank the well, other men erected a stand for a 10,000 gallon wooden stave tank, still other men built the tank, and other men ran a two-inch pipe line down to the large circus tent, which was our temporary commissariat.

We ran in two miles of track to unload material, building a miniature railway yard with necessary spurs, switches, etc. An average of fifty carloads of material a day was handled through this yard for the period of June 26th to September 1st, but during the last three weeks of August this yard handled over one hundred cars per day. We made it a rule that before we quit at night every car of material was unloaded and the cars out of our yard. We had to adopt this means because we never could tell what the next day's receipts would be. In only one or two isolated cases was any demurrage paid on cars at Camp Devens. We installed twenty sawmill units for cutting lumber to dimension. The lumber would come in in cars and would be piled behind a sawmill unit, cutting to dimension only the size of lumber contained in the car. As soon as a car arrived gangs of men would start unloading it into piles, while a government sealer checked it for audit purposes. It would then go through the sawmill unit to be cut to dimension, and would be loaded direct onto teams or trucks and rushed up to the job. We built forty buildings for our laborers, each sixteen feet by one hundred and five feet,—sub-divided through the center with a partition, and sub-divided again lengthwise into a number of small compartments, each about eight feet by eight feet. In each of these compartments two men had their quarters. All our labor was housed in these shanties at the start of the job, but as soon as we completed permanent barrack buildings, the skilled labor was moved from these shanties into the barrack buildings, and the shanties were turned over to the rough labor. Thirty buildings were built for our commissariat department, of which three are what is known as the central commissary group.

In these buildings I have seen 2,800 men fed in twenty-two minutes. We served at Camp Devens during the period of June 26th to September 1st, an average of 17,100 meals per day, though at the peak of the job in August, over 29,000 meals each day were prepared in this kitchen. On the basis of 17,000 meals per day, it means the preparation of about ten and one-half tons of solid food, and about 1,000 gallons of tea, coffee, and ice cream. From this kitchen such items as 1,200 dozen doughnuts for breakfast came, and in August the Italians simply could not be quiet until they had consumed (and I use the word advisedly) about 650 gallons of spaghetti. One thing that you would have noted about this kitchen, had you been at Camp Devens, was the total absence of flies, even though the kitchen is of wooden structure and consequently not built with great consideration given to the sanitary aspect of things. When our men first looked over the site of Camp Devens, they were annoyed by one of those local pests that you find in every community—the oldest inhabitant, who informed us that we would never build the camp as it took "five smudges to keep the flies and mosquitoes away from me when I wished to fish in Robbins Pond." Forewarned is forearmed. We put a large sanitary crew at work. They cleaned up all the refuse on the reservation, filled in the low spots, put oil in all the water, and attended to the sanitary records of the Camp, and the result was that we were not bothered by flies or mosquitoes all summer. Several storehouses were also erected.

At no time on Camp Devens did we have over a day and a half material ahead of us, but sometimes plumbing or electrical fixtures would come in faster than we could use them, and they were kept in these storehouses. A blacksmith shop and garage were built in the form of a quadrangle, two sides being given over to garage accommodation and two sides to blacksmith accommodation. Efficient crews here kept all our equipment active. A pipe-threading plant, erected for threading in accordance with Government specifications all pipe used on Camp Devens, was a great task in itself.

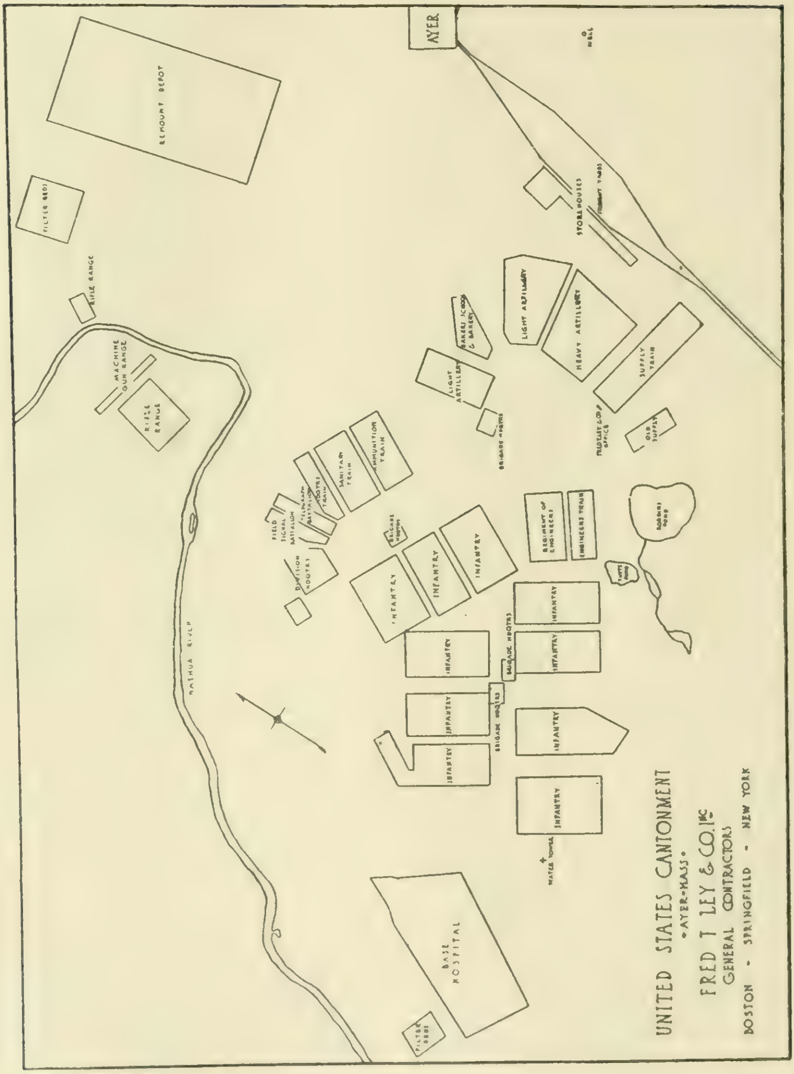
There are a whole lot more buildings I have not time to show, such as the fire station. When we first inspected the site of Camp Devens, we found the fire hazard to be a tremendous one, owing to the large number of scrub oak that had to be cleaned off and burned, the millions of feet of dry lumber lying around, and the scarcity of water. We built a number of watch towers all over the Camp and connected them by telephones to three fire stations, each equipped with two motor truck chemical apparatuses. As soon as smoke could be seen, an alarm would go in, and the skilled fire fighters would go out and put it out. We had numberless fires in the brush, but we are proud to state that while we maintained the public utilities on Camp Devens, we did not lose a dollar's worth of government property by fire, and in that we understand we are unique as all the other Cantonment Camps suffered fire losses.

At last, but not least, we had to clear off the scrub oak—and make about twenty miles of roads through the Camp under conditions such as you see. The land at Camp Devens, as you know, is rolling land with a difference in elevation across the Camp of over seventy feet, which made our road problem a difficult one. Large gangs were used together with extensive digging machinery for getting roads through so that we could build our buildings.

We have here a layout of Camp Devens itself. On the right you see the town of Ayer on the Boston & Maine railroad. Here are the classification yards for the railway and along here are our storehouses for the reception of material. Here you find the barracks starting. First is the supply depot and then the supply train, the heavy artillery, the light artillery, the camp bakery. More light artillery, with brigade headquarters behind it, the ammunition train, the sanitary train, head quartermaster's train, field signal battalion, headquarters, three regiments of infantry, three more regiments of infantry, four regiments of infantry with one regiment of engineers.

On the left you see the base hospital with its own filter beds and over beyond the Nashua River, with rifle ranges. Up beyond Ayer the Remount Station, with the filter beds to the left. Here is the well from which the water supply comes, and here are located the water towers for fire purposes. This whole layout that I show you comprises about 13,000 acres.

Each regiment has quarters by itself. Each barracks has a lavatory building beside it. The stables are at the left, and


AYER
REMOUNT DEPOT
FILTER BEDS
RIFLE RANGE
MACHINE GUN RANGE
RIFLE RANGE
STOREHOUSES
FREIGHT YARDS
LIGHT ARTILLERY
HEAVY ARTILLERY
BAKERS SCHOOL & BAKERY
LIGHT ARTILLERY
SUPPLY TRAIN
BRIGADE HDQTRS
AMMUNITION TRAIN
SANITARY TRAIN
TELEGRAPH BATTALION
FIELD SIGNAL BATTALION
DIVISION HDQTRS
BRIGADE HDQTRS
INFANTRY
INFANTRY
INFANTRY
REGIMENT OF ENGINEERS
ENGINEERS TRAIN
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INFANTRY
INFANTRY
NASHUA RIVER
WATER TOWER
BASE HOSPITAL
FILTER BEDS
UNITED STATES CANTONMENT
• AYER-MASS •
FRED T LEY & CO. INC
GENERAL CONTRACTORS
BOSTON - SPRINGFIELD - NEW YORK

officers' quarters at the right. The roads run at the back of the individual barracks buildings so as to be near the kitchen.

The layout of a typical barracks building is at the right, the kitchen, then the mess hall, a hallway, then a dormitory. The kitchen only extends one story, whereas the rest of the building extends two stories.

On the second floor is the dormitory, and you see also the comparative height of the kitchen to the rest of the building.

In a company lavatory there are ten showers, a hot water heater and water closet accommodations for twelve men. These lavatory buildings are not built on a post foundation like other buildings, but are built on concrete foundations for sanitary reasons.

With their mechanical equipment and concrete floors these buildings are very hard to construct. Many interesting records concerning speed in setting plumbing fixtures were made on these buildings. Three plumbers, working with helpers, used to caulk in ferrules and set the stools for about seventy fixtures per day.

In our original contract at Camp Devens we had to complete by September 1st, according to schedule, 635 buildings, the bulk of which were barracks and lavatories to the number of about 450 buildings. Actual construction on these buildings was not commenced until about July 20th, leaving only about forty days to complete them in. In addition to this we had to put in water, sewerage, sewage disposal, electric light and telephone systems for this city of 40,000.

The construction of a typical building was about as follows: First, we had to get a road in to deliver our material, and, secondly, we had to clear off the scrub oak so that we could work.

Then the engineers came along and drove stakes and nailed boards to these stakes to show the levels and lines of the buildings.

Following them, men dug post holes, dropped a wooden pad into the bottom of the hole which is about three feet six inches deep, and then bed in the posts. These posts are then cut to grade and the floor construction immediately placed upon them. Following this the floor joists are placed and the finished floor nailed on. This then gives the men a level surface to work on to complete the rest of the building. In nearly every case in order to get our floor down we had to dig out dirt at one end of the building and then support the other end of the building on posts anywhere from four to eighteen feet in length.

The next step was the framing, and the next the wooden wainscoting that goes around the interior of the building about five feet high. After this the sheathing, or novelty siding, is nailed on the outside of the building over building paper, the rough roofing nailed on and covered with rubberoid roofing in sheets, and above the wooden dado inside is nailed wallboard, leaving a four-inch dead air space in the wall to help keep the building warm in winter.

The water supply was a very important factor at this Camp. It was estimated that there would be needed to be used about 2,000,000 gallons of water per day, and we had to install a supply and pumping system as well as installing some thirty-seven miles of piping.

Good water was to be had on the site through wells, and we, therefore, excavated a well fifty-two feet in diameter and twenty-six feet in depth. Water came in so fast while we were digging that it took all the pumps we could get to keep it down so we could go ahead.

For fire purposes it was necessary that there be water storage, and, therefore, we had to build four tanks, on concrete foundations, a capacity of 400,000 gallons of water.

It is a hard job to give you an idea of the construction of a job like this without actually taking you over it. Words are not equal to expressing the thrill that you get from being where nine thousand odd men are working at top speed. Come with me for a day to Camp Devens and I will take you over the job. Let us start down at the railroad station in the morning at Ayer. As we leave the station we see the freight yards in which you see our checkers busily at work locating cars of material to be later moved by switching engine up to the yards for unloading. Our average daily receipt of material at Ayer was about fifty carloads. Following up the line of the Boston & Maine we come to our own yards. There we find men busily engaged unloading the cars and placing the material at most advantageous points. In this picture lumber is being unloaded directly behind our sawmill units, while checkers busily scale it. Before long it will be rushed through sawmill units to be cut to dimension, and as fast as it comes through it is loaded on the trucks and away it goes. If it is a sewer or water pipe that is going in it is loaded directly on to teams and away it goes; while if it is other material not necessary for construction on that day it is either placed in piles or put in storehouses.

Let us get aboard one of the trucks and go with it. You will find that the truck driver has in his possession a slip of what actually is on his load and for what building and what portion of that building it is intended. He drives along the main road until he comes to another intersecting road and lest he should make any mistake a guide stationed at this point looks at his slip and instructs him regarding the proper road. Notice the trucks around us—the one ahead is full of posts, the next one is full of floor joists, the next one has studding, the next building paper and nails, etc., and they are all going in the same direction as we are. Soon we notice the trucks stopping to unload. You will find where men are digging holes, the load of posts and almost before the load is dumped the men are setting these posts in the ground and bedding them in. The truck of joists has stopped at the next building and almost as quickly as they are dumped they are being nailed into place. And so on it goes. We see that each truck load has a certain definite relation to a certain definite building. In other words, material is being delivered exactly as required, and there is no delay of any kind owing to material being delivered too late or too early. Things are too carefully watched for that. In other words, all motions are synchronous like the wheels of a clock.

The load of water pipe we saw going up the road we find is being laid almost behind a big trench excavator, and almost as fast as it is laid, and inspected, it is covered in. In some places you see that the sewer pipe is going in ahead of the water pipe; some places it is the reverse, but you can't help but notice that things are being completed in unison all the time—you do not see a big block of buildings in a partial stage of completion, you can see everything moving with a definite growth all the while. Everything is moving to the same objective—completion by September 1st.

You will probably notice the large numbers of teams, trucks and motor cars you see on the work. It is no wonder. We had over 200 teams on the work most of the time and about 140 motor trucks. The men you see driving madly around in motor cars are our superintendents, while the men riding horseback are timekeepers, some sixty in number. Now and again you will see gangs at work erecting poles. They are for telephones, electric light, and to carry the pipes for the heating system. The steam shovel you see at work is leveling the side of a hill so we may place a building where the plans show it should be. And so it goes. I could talk indefinitely on the things you would see on a trip over the work.

I told you before that our schedule called for completion of 635 buildings by September 1st, of which approximately 450 were barracks and lavatory buildings, but by actual count we completed 842 buildings or about *one-third more than our original contract called for.*

Let me enumerate some of them. There were forty regimental storehouses, ten quartermasters' stores, fourteen heating plants, a Y. M. C. A. auditorium, which seats 2,800 people, a group of ten other buildings put up for the same organization, three buildings for the Knights of Columbus, and a bakery with a capacity of nearly 80,000 pounds of bread a day. In the rear a coal trestle was erected.

To care for perishable products, we built a cold storage warehouse. In the meat cooler portion of this alone can be placed the meat of 120 beef cattle. We also completed a transformer station for receiving electric power from the New England Power Company.

In all there are about 180 buildings, of which these are a few.

To take care of the sewage from the main camp we constructed twenty acres of sand filter beds as you see. And to treat the sewage from the hospital unit we constructed one and one-half acres more.

As regards speed of construction, it averaged, from June 26th to September 1st, a building completed every forty minutes, or accommodation supplied for a new soldier and his equipment every forty-eight seconds we worked.

All the while we worked the men had to be fed—our average daily force in our commissariat was 400 men, and we served a daily average of 17,500 meals. All told, about ten tons of eatables had to be prepared daily, and about 2,000 gallons of milk, soup, coffee and ice cream were needed.

Labor was a big item, also, as at times we had a force of about 10,000 men working, including office staffs and engineers—and we proudly point to the fact that ours was the only cantonment in the United States that from start to finish was not delayed by strikes—and that is a notable achievement when you consider that our average daily force was over 5,500 men. And while the Camp was maintained by us, not a dollar of Government property was destroyed by fire.

As constructing quartermaster on the job, Captain Edward Canfield, now promoted to be a Major, was what might be termed the Government's business agent on the site. We are greatly indebted to Captain Canfield and his associates for the able assistance they gave us in every way. Except for this able coöperation we would have been handicapped in many respects. Government contracts, as a rule, are supposed to be tied up so tightly with Government red-tape that it is impossible to do anything as it should be done, but if this red-tape exists in Governmental work as manipulated by Major Canfield, this red-tape is, so to speak, non-existent.

In charge of Camp Devens, Mr. Barbour, as supervising engineer, was responsible for the layout of all buildings, roads and railroads, detailing of the water works system, the design and detail of the sewerage and sewage disposal system, the design and detailing of service drains, detailing of steam distribution in boiler plants, the location and planning of the Remount Station, and supervision of work of all kinds. This in itself would be some task, but when you consider that Mr. Barbour and his associates had to execute the aforementioned work at the rate of speed to stay in front of us, you can realize that their task was a big one, and without the cordial coöperation rendered us by Mr. Barbour, we would have been unable to make as fine a showing as we did.

Camp Devens, as completed, has 1,371 permanent buildings, and about 200 of temporary construction, and cost, complete, approximately $9,000,000, for which work we received a fixed fee of $250,000. We have a new contract for this Camp for any alterations, repairs or additions, which is keeping a large force of men occupied.

(At the completion of this talk Mr. Goggin showed two reels of moving pictures illustrative of the vastness of the project.)

THE SOUTH STREET CUT-OFF AND OTHER SEWER CONSTRUCTION IN TUNNEL

By Willard S. Brewer, Mem. Conn. Soc. C. E.

The South Street Relief Sewer has been built for the purpose of relieving the lower portion of Franklin Avenue from flooding during severe storms; thus accomplishing for this locality the same result obtained for the upper portion of this street by the construction of the Elliott Street cut-off in 1903-4. In order to get the whole problem in mind it is perhaps well to give a brief history of the sewer development of this section.

That portion of the Franklin Avenue Sewer District, lying within the City of Hartford, includes the area between Wethersfield Avenue and Fairfield, New Britain and Retreat Avenues, a total area of about 1,167 acres. It is extremely regular in its contours, being shaped like a huge trough with its bottom located at Franklin Avenue, and its low end at Folly Brook. It is entirely independent of the main sewer system of the city. In 1872 a trunk sewer was built in Franklin Avenue from Folly Brook to Morris Street, beginning six feet in diameter and diminishing to three feet at its upper end. Later a twenty-inch pipe line was constructed to take the sewage flow to the Connecticut River, near the outlet of the Wethersfield Cove. By 1900 the northern part of this district was fairly well built up and trouble began to develop in the shape of cellar flooding in Franklin Avenue, north of Bond Street, during excessive storms, and to relieve this condition there was constructed in 1903-4 a cut-off through Elliott Street from Franklin Avenue to the meadows east of Wethersfield Avenue, designed to take all excess storm water north of Bond Street to the ditch in the meadow, whence it would eventually find its way to the Folly Brook, near its junction with Wethersfield Cove, and thence would discharge to the Connecticut River.

The built-up portion of this district has been steadily advancing southward until it has now reached South Street west of Franklin Avenue and has gone below here east of this avenue.

In 1914-15 the Maple Avenue sewer system, so called, providing for an area of about 240 acres east of Fairfield Avenue (being a part of the Franklin Avenue district), was constructed, the entire run-off being delivered at the junction of South Street and Franklin Avenue through a five-foot six-inch circular sewer.

Of course, there has always been a good deal of surface flooding throughout the lower portion of the avenue during hard storms, but on account of its undeveloped state it has resulted in little real damage. For the last five, or more, years there have been no catch basins built below South Street. The few basins already there took some of the water and the remainder continued to flow in the gutters to Folly Brook. In excessive storms the entire street became a river. Less damage resulted from this than would have occurred if it were allowed free access to the sewers only to back into the cellars of the houses.

However, it was realized that the continued development of the section, coupled with the fact that the completion of the Maple Avenue System would bring directly to the Franklin Avenue sewer large quantities of water, which hitherto had flowed over the surface of the ground, would result in serious cellar flooding in hard storms.

Therefore, steps were taken in 1914 to lay out a relief sewer in South Street from Franklin Avenue easterly to the meadow ditch, the same ditch that the Elliott Street cut-off discharged into. An appropriation of $50,000 voted on at the city election in 1915 was defeated, but in 1916 was passed. Actual construction was begun in December, 1916, and except for the connection to the South Street sewer, was completed in December, 1917.

The design of the sewer was based on the following considerations: The capacity of the Franklin Avenue sewer from Folly Brook to Bushnell Street is 200 c. f. s. The run-off of the area directly tributary to this sewer between South and Bond Streets is calculated to be 200 c. f. s.; between South Street and Folly Brook to be 200 c. f. s.; both figured for well-built-up residence sections. The South Street sewer from the west has a capacity flowing full of 285 c. f. s. It would, therefore, seem that the relief sewer at South Street should have a capacity sufficient to take the entire discharge from the west and north, namely, 285 c. f. s., plus 200 c. f. s., or 485 c. f. s. as the run-off below South Street is just equal to the capacity of the Franklin Avenue sewer.

However, it is expected that direct overflows from the local sewers near Folly Brook will be able to divert about 75 c. f. s. into the brook, thereby allowing us to let that much by South Street. The Relief Sewer is therefore designed to carry 285 c. f. s. from the west, plus 125 c. f. s. from the north, or 410 c. f. s. The section adopted was of horseshoe shape, 73½ inches in height and 66 inches wide, equivalent in area to a six-foot circle. The meadow it discharges into is subject to flooding from the Connecticut River and the theoretical capacity varies from 380 c. f. s. to 440 c. f. s., depending on conditions assumed as to level of river water and water in the Franklin Avenue sewer.

In the construction of this sewer about 1,100 feet was built in tunnel. Although the appropriation was voted in April, 1916, the letting of the contract was purposely delayed till the following fall in order that the tunnel work, the heaviest part of the job, might be done in the winter months when labor and teams were easier to obtain, and when also the necessary survey work could be handled to better advantage by our local force.

It was planned that the open-cut work in the meadow should be done before freezing weather in order to obtain drainage for the tunnel; that the tunnel should be done in the winter and spring and the open cut east of Franklin Avenue be done in the spring and early summer. However, this job was no exception to the general rule of delays and winter broke upon us last December with the connection to the South Street sewer from the west still untouched, but, however, all other work fully completed.

The tunnel was mostly in clay for the full section, but for a short distance under Wethersfield Avenue rock and hardpan were encountered, the highest point of rock being four feet above the flow line. All bracing and sheeting was of wood. Where the entire section was in clay, there were used 8″ x 8″ posts set on foot blocks with 4″ x 6″ spreaders at their lower ends; 8″ x 8″ caps and two-inch lagging. The supports were generally placed four feet on centers and the procedure was as follows:

The upper portion of the heading, generally about three-quarters of the section, is excavated ahead for four feet and the cap placed in position and held there by a jack supported on a foot-block about one foot above the flow line of the sewer; the roof boards then placed (while this is being done the clay remains in its original position, there being very little tendency to come down during the hour or two it is unsupported); holes are then dug to receive the posts; posts set on foot-blocks placed below the bottom of the future invert; jack removed; bottom spreader placed; excavation trimmed up. The excavation is carried only to a level about ten inches above the flow line at this time, and on this is laid a narrow-gauge track on which are operated swivel dump cars to dispose of all excavated material. As the heading advanced, moisture seeped through and the bottom began to soften. It was found advisable to stop when sections ranging from 50 feet to 150 feet had been timbered, excavate to grade in short sections (twenty to thirty feet), place the invert, relay the track and proceed once more with the heading.

In that portion of the tunnel where the lower part of the heading was in rock, the roof timbering was the same as for clay, the posts resting on the rock at varying distances below its top surface, depending on the way the rock broke out.

When the entire heading had been excavated and invert placed, the sidewalls were started midway between shafts, and progressing toward shafts. The arch was built in the same procedure. Both invert and sidewalls were of plain concrete, 1-2-4. The arch consists of the inner ring of the Natco block sewer with the space between this block and the timber lining of the tunnel filled with 1-2-4 concrete. Centering six feet long was used, the block laid, the concrete above it placed, the center pulled ahead and the operation repeated. We were apprehensive at first that on account of the joint of the block being only four and five-eighths inches in depth there might be some deformation of the arch if the centers were pulled directly after the placing of the concrete, but not the slightest trouble was experienced.

The material was removed from the tunnel at three points, at the easterly end of the tunnel, at the shaft near Wethersfield Avenue and at the shaft 600 feet west of Wethersfield Avenue. The latter shafts were served by one hoisting engine placed midway between the shafts. The head houses were similar at these two shafts, and were so arranged that the loaded cages were lifted to a platform about ten feet above the street level, the car dumped forward so that the material slid down a shute directly into the wagon. The material was disposed of over and adjacent to the open cut section of the sewer in the meadow.

The progress in the headings encountering clay for the full height averaged slightly over one set of timbers placed every day, or a little better than four feet. Only one shift of nine hours was worked, the gang being two heading men and two muckers, who also operated the cars in the tunnel until the heading had progressed quite a ways from the shaft, when an extra man was provided.

The progress on the arch for one gang of two men was at the start six feet, quickly increased, however, to twelve feet, which is to be considered an average rate. At times when two gangs were working the spirit of rivalry increased it to as high as sixteen feet.

Approximate costs figured for the portion of the tunnel in clay, including all costs of driving and timbering the tunnel, but not the shaft work, gave $4.50 per cubic yard of material excavated, equivalent to $12.00 per linear foot.

The method used for taking line into the tunnel was very simple and fairly speedy. Two twelve-pound cast iron spheres were hung in pails of water by braided cord from the timbers at the top. A transit on top lined in the bobs by sighting directly at the hanging cords; another transit in the tunnel was balanced on the cords and threw the line into the heading. On account of the movement of the clay in coming to a firm bearing on the timbering and the consequent movement of the timbers it was necessary to check the line at frequent intervals.

The special work at Franklin Avenue to divert the water to the relief sewer deserves some comment. A glance at the drawing shows that it is necessary to change the Franklin Avenue flow from a southerly direction to an easterly one and this is done by a weir and the diagonal channel. The South Street flow is hardly changed in direction and is carried directly across the Franklin Avenue sewer nearly at grade. The weirs have been built to two-thirds of the height of the Franklin Avenue sewer, the idea being to allow no overflow to take place until it is necessary to do so. Observations will be made during storms and the weirs reduced as it is deemed advisable. It is expected that eventually they will be cut down to eighteen inches in height and also that the one at the junction of the new relief channel and the five-foot six-inch South Street sewer will be removed entirely.

There have been several other tunnel sewer jobs in the city in the last ten years and the construction methods used have been very similar to those described here. In the first tunnel of the Homestead Avenue Interceptor six-inch by six-inch transverse sills were used to place the posts on. Short pieces of two-inch plank under the sill gave additional bearing area. In a later tunnel for an extension of this latter sewer steel posts were used for several hundred feet. This post was of an H section four inches in depth, and placed with the web transverse to the sewer, the two-inch lagging being held by the inside flange so that when the timbering was complete the only part of the post showing was this flange. Their use resulted in considerable saving in excavation and concrete.

DISCUSSION.

Mr. Saunders: What is the method of figuring the run-off? What rainfall is allowed for?

Mr. Brewer: We used an intensity of 2.7 inches an hour. Our method has been brought down from Hering's report on Hartford's sewer system in 1893. In a well-built residence section 55 per cent of the amount is assumed to run off. The results have been checked up by using the Metcalf & Eddy formula for New England in which the rate varies with the time. This formula is $i = 12/t^{0.5}$ where i is the intensity of rainfall in inches per hour and t is the duration in minutes. The rate for twenty minutes with this formula is 2.7 inches, which is the same as recommended by Hering. For twenty-five minutes it is 2.4 inches an hour. There has been a great deal of variation in the percentage of run-off to use. Authorities, of course, use a great many different values; but in plotting up a curve using a value of 40 per cent run-off for ten minutes, running up to 75 per cent if the storm continued about two hours, 1¼ cubic feet a second to 1.4 for average conditions, per acre of territory considered, was obtained.

Mr. Saunders: Is that a modification of the Burkli-Ziegler?

Mr. Brewer: It is the Burkli-Ziegler with exponents raised one figure, generally known as the McMath.

It is $Q = ci\sqrt[5]{A^4S}$

Mr. Saunders: This is a modification of it to suit local conditions?

Mr. Brewer: The intensity is quite high for short periods and diminishes as the time increases. The formula to Burkli-Ziegler checks very well with the results from Metcalf and Eddy.

Mr. Peck: Will you tell them whether you always found 2.7 sufficient allowance for Hartford?

Mr. Brewer: Not the last year. We have had considerable flooding in some places; but I am of the opinion that if the sewers are designed for 2.7 inches it is sufficient in 90 per cent of the cases to take care of the excessive rainfall in those two or three storms of last summer.

Mr. Bunce: I am quite interested in the schemes which have been adopted for the relief of the Franklin Avenue sewer, because in 1872, when I was first elected as City Engineer for the City of Hartford, I found that the contract for that sewer had been let, and it was turned over to me to construct. I came onto that work just as green as anybody possibly could be. I had never built a sewer in my life; never had had anything to do with a sewer. In addition to the six-foot Franklin Avenue sewer, which was then the largest sewer in Hartford, I found about three or four miles of sewer let, to be constructed all over the city. I go into the City Engineer's office sometimes now and compare the force working there with the equipment I started with. It consisted of an old Irishman who had a horse we used whenever we had sticks long enough to hit him on the head and make him go. That sewer was originally laid out six feet in diameter through its whole course to Maple Avenue; and, against my protest, sections of it were decreased to the present size. It was evident to me, even as far back as that time, when there was but one house on Franklin Avenue, and when, in order to build that sewer, you had to wear a pair of hip boots to get onto the ground, that some time that sewer was going to be too small for the natural flow which would arise when the country was built up. Now, as you look at the section, you can hardly find a vacant lot anywhere on the Avenue, or east or west. Before I got out of office I was hit in the head so hard every time it rained that I dreaded to see the clouds come into the sky.

THE PROPOSED BUILDING CODE OF THE CITY OF HARTFORD

By George L. Mylchreest, Mem. Conn. Soc. C. E.

The subject of my paper has been announced as the new Building Code of the City of Hartford, but as the code which I am to discuss has not been adopted and has not even been presented to the Council for adoption, the word "proposed" should be inserted in the title instead of the word "new." The code is in the hands of the printers and will undoubtedly be ready for distribution this week.

Why a new code for the city of Hartford? To answer this question fully, it will be necessary to review a little of the history of the building department. Twenty-six years ago the office of Building Inspector was created. The officials, then as to-day, consisted of a building inspector and a deputy inspector who are appointed by the Mayor, with the consent of the Board of Aldermen, for two-year terms.

The municipal ordinances concerning building construction were adopted in 1895, and were amended and added to from time to time, and in 1908 a general revision was made, but not many new regulations were added at that time.

In 1912 it was realized that the present building ordinances, although containing a few good features, were devoid of many essential provisions covering subjects such as fire-proof construction, reinforced concrete construction, fire walls, structural steel and iron construction, safe loads for buildings, allowable working stresses on all building materials, and many others equally important. As a whole, the present ordinances are entirely inadequate and obsolete.

In 1912 the Mayor appointed a commission of eight to prepare a revision of the building code. The commission engaged Ford, Buck and Sheldon, Inc., as consulting engineers, to prepare the code for discussion and review by the commission. In December, 1913, the proposed revision was finally accepted by the commission, printed and presented to the Council for action. It was tabled at that time and again in 1915 it was brought up for discussion, and tabled.

In November, 1916, the Mayor appointed a committee of two aldermen, two citizens, and the corporation counsel to confer with the Building Code Commission appointed in 1913 and to recommend to the Council a suitable building code for adoption. The same firm of engineers were again retained as consulting engineers and began the complete revision of the former proposed code.

THE PROPOSED NEW CODE.

The proposed new code differs materially from the 1913 proposed code. The re-grouping of the various sections into articles and the sub-division of the sections, make the new code more like a handbook, and information desired is more readily obtained. Many new provisions are incorporated and the old provisions have been modified to bring them up-to-date.

It is not claimed that the proposed new code is perfect in all respects; amendments will be necessary to keep the code abreast the times; but it is maintained that the proposed code is infinitely better than the present code and is a good foundation to build on.

The code may be roughly divided into four parts: 1, Organization and administration of the department; 2, Provision for building construction; 3, Provisions for installation of plumbing systems; 4, Provisions for installation of electric wiring. Naturally, the provisions for building construction are the most extensive, as here we find twenty-five of the thirty articles. These may be grouped into two divisions: (a), General provisions covering all forms of construction; (b), Provisions covering special forms of construction.

Under (a) may be mentioned the provisions for (1) quality and strength of materials entering into construction, (2) loading of buildings, (3) permissible loads on soils, (4) restriction on types of buildings within certain areas, (5) fire protection of buildings, (6) design of wood joists, beams, girders and columns, (7) chimneys, flues, fireplaces, (8) boilers, furnaces, stoves and ranges, (9) stairways and other exits, (10) roof construction, (11) miscellaneous.

Under (b) may be mentioned provisions for (1) frame construction, (2) mill construction, (3) fireproof construction, (4) structural steel and iron construction, (5) reinforced concrete construction, (6) elevators, (7) garages, (8) motion picture machines, and (9) theaters and other places of amusement.

Looking at the administration provisions, we find that the chief of the department, called the supervisor, is appointed by the Mayor with the approval of the Council, for a term of two years, or until his successor is appointed. The other officials of the department, which consist of a building inspector, assistant building inspector, a plumbing inspector and an assistant plumbing inspector, and an electrical inspector, are appointed by the supervisor after they have passed a satisfactory examination prepared by the supervisor. They hold office as long as the supervisor who appointed them holds office, but they may, without re-examination, be re-appointed by the succeeding supervisor. By combining the building inspection, plumbing inspection and electrical inspection in one department, under one chief, it is anticipated that a considerable saving can be made in inspection and the work handled more effectively and efficiently.

Concerning the fire limits, it is worth noting that there are provisions for inner limits and outer limits. The inner limits cover approximately the present fire limits, which include the congested value district and some small additional territory, a total of 376 acres, and within this area no buildings can be erected of other than first-class mill construction or of fireproof construction. The outer limits, which cover about four times the area of the inner limits, extend as far south as Wyllys Street, Jefferson Street, Ward Street and Park Street; west to Garden Street, Sigourney Street, Laurel Street, and including the Capitol City Lumber Company's new yards on Park Street; north to Sanford Street, Capen Street and Homestead Avenue; and east to the railroad tracks of the New York, New Haven and Hartford Railroad Company. Within the outer limits the requirements are less stringent; all types of buildings, except buildings of frame construction, are permitted therein.

The wood shingle roof is prohibited within the fire limits and repairs to present shingle roofs within these limits shall be limited to the extent of 10 per cent in any one year. In case repairs to a greater extent are necessary, or in case the roof has been damaged by fire to the extent of 30 per cent of the cost of replacement, it shall be removed and replaced by a fire-resistive roof covering. In some cities where a large conflagration has occurred, the hazard of the shingles in spreading the fire due to flying fire brands has been realized and the shingle as a roof covering has been prohibited entirely within the city limits. Recently Atlanta had an extensive and disastrous fire in the residential district, and the sole cause of the conflagration was the shingle roof which was readily ignited by the flying fire brands. Immediately after the fire, stringent ordinances were passed which excluded the use of shingle roofs on any new structure within the city limits and which will gradually eliminate shingle roofs from all present buildings during the next twelve years.

In addition to the requirements for fireproof buildings within the inner fire limits, in certain cases this type of construction shall be used for buildings situated in any part of the city. Such buildings include those occupied by persons receiving medical, charitable, or other care or treatment, or in which persons are held or detained under legal restraint, every public building over forty feet in height or exceeding 5,000 square feet in area, every tenement exceeding six stories in height, every factory building over five stories or sixty-five feet in height, every office building over seventy-five feet in height, and certain other business and residence buildings under certain conditions of size, height, occupancy or location.

It will be unnecessary to describe in detail the provisions for materials of construction. All of the principal materials are fully defined and their safe working stresses are tabulated for ready reference.

It is, of course, useless to define the safe working stresses of materials unless the loads to which the materials are subjected are also defined. The weights of materials entering into the construction of buildings are tabulated, and reference to this table will enable one to determine the "dead load," that is, the immovable and constant load. The "live loads" or movable loads, to be used in the design of structural members, are defined for practically all structures. The live loads on floors consist of (1) a uniform load per square foot of floor area; this is to be used in the design of floor construction, beams, girders and columns; (2) a concentrated load which shall be applied to any point of the floor for the design of beams and girders; (3) a uniform load per linear foot of the girders.

The load which produces the maximum stress shall be selected for the design of the member.

It is worth noting that the capacity of the floors in business buildings shall be posted in a conspicuous place.

The live load to be assumed for roof construction varies with the span and slope of the roof. For roofs having a span of eighty feet or less, a live load of thirty pounds per square foot of horizontal projection shall be used for the combined effect of snow and wind. For roofs having a span in excess of eighty feet, a snow load of twenty-five pounds per square foot of horizontal projection of the roof shall be used for all slopes up to twenty degrees, and one pound less for every degree up to forty-five degrees, above which slope no snow load need be considered; and the horizontal wind load shall be assumed at twenty pounds per square foot of the vertical projection of the roof.

The present regulation concerning excavation adjacent to your neighbor's building is merely the common law which has maintained that the owner of the neighboring building shall take care of the foundation of his building, no matter how far down you go with your excavation adjacent to his building. In the new code, we provide that the owner of the neighboring building shall provide foundations for his building down to a depth of only ten feet below the curb, and below that depth the person making the excessive excavation shall, at his own cost, provide the foundation and maintain the building in a safe condition while the foundation is being constructed.

The construction and the loading of pile foundations, both of wood and of concrete, are fully provided for. In order to help engineers and architects obtain an idea of the carrying capacities of piles in Hartford, it is provided that all records of tests of piles shall be filed in the office of the supervisor and they shall be open to the public at all times.

The various details of length, height, thickness, bracing and bonding of walls and partitions of brick, tile, concrete and stone are next provided. In order to control the quality of the manufactured article, it is provided that a license shall be obtained from the supervisor by all persons, firms or corporations intending to manufacture concrete blocks and cast stone.

Provisions for fire prevention and for retarding the spread of a fire are very thoroughly specified. They include provisions for fire stops for all furred walls, framed walls and partitions. The importance of providing fire stops is realized and provisions are also made for the examination by the supervisor of all such fire stops before the owner or builder places any lath or plaster to cover them up. Another fire prevention feature is the provisions for fire walls and fire partitions to separate floor areas from each other and to prevent fire from spreading throughout the entire building. The code provides for maximum areas between fire walls.

If the requirements given in the proposed code had been followed by Edison during the construction of the buildings which were recently destroyed or severely damaged by fire, the damage would have been but a small fraction of that suffered. Edison had no fire walls nor partitions to check the spread of the fire and the construction was such that he had some excellent concrete "stoves" with excellent flues and no dampers.

Shafts extending through one or more floors should be properly constructed with a view to preventing fire from spreading from one floor to the other. During the recent fire in the Connecticut Hospital for the Insane at Middletown, fire which destroyed only the upper two stories traveled down some of the dumbwaiter shafts to a depth of three stories below the general level of the fire. If the shaft had not been of fireproof construction, the fire would have spread to all floors and probably would not have been checked until the entire main building had been destroyed.

Miscellaneous provisions covering piers, arches, vaults, sills and lintels are next given, followed by provisions for chimneys, flues and fireplaces. Improper construction of chimneys, flues and fireplaces has been the cause of a large number of fires in residence buildings. The installation of boilers, furnaces, stoves and ranges and their heating pipes and registers in a proper manner is a necessary fire prevention feature.

The roof construction, including roof coverings, anchorage of roofs, cornices, gutters, skylights, scuttles, tanks, pent houses, snow barriers and roof gardens, is fully provided for. The roof coverings are limited to fire-resistive roofing materials within the inner fire limits, the wood shingle being permitted only outside of these limits, and then only in connection with buildings of frame construction or of ordinary construction.

The design of wood joists, beams, and columns is fully defined and a tabulation of maximum spans for floor joists are given for reference.

The code also provides for frame construction, which is permitted outside of the fire limits and then only for buildings not exceeding forty feet or three stories in height, and not exceeding 5,000 square feet in area.

As the new code permits buildings of mill construction within the fire limits, this type of construction, when used therein, shall conform strictly with the provisions of the code.

As I have mentioned previously, the new code requires buildings of fireproof construction within the inner fire limits and also for certain buildings outside of these limits. Strictly speaking, there is no absolutely fireproof building. What is required for buildings of fireproof construction is a certain degree of fire-resistiveness which will render them safe against ordinary fires of short duration. It is not to be expected that a building constructed in accordance with the provisions of this code for fireproof construction would pass through the heat of a fire in a celluloid plant and emerge undamaged. The damage, however, would probably be purely local and would not seriously endanger the building as a whole. The chief provisions for fireproof construction consist of the following: (1) Encasing the structural steel and iron work in fireproofing materials, (2) Building all walls and partitions of masonry or other equally fire-resistive material, (3) Building floors and roofs of tile, brick, concrete, or other equally fire-resistive materials, and (4) Protecting door and window openings with fire floors and fire windows where necessary.

The provisions for design and details of structural steel and iron construction are in accordance with the latest engineering practice. The design of compression members and of built-up plates and angle beams follows the formulæ adopted by the American Bridge company after an exhaustive series of tests on full size specimens. Through the courtesy of Mr. Edwards, of that company, the writer had an opportunity of examining the records of these tests and he is fully convinced that the formulæ adopted are better than any other heretofore presented.

The use of concrete-filled steel pipe columns, of the type of the "Lally" column, is restricted to those columns which have been completely filled with a dense concrete in the presence of the supervisor or in the presence of an inspector satisfactory to the supervisor.

The most recent developments of reinforced concrete design is embodied in the provisions for reinforced concrete construction. The well-known report of the Joint Committee, published in the December proceedings of the American Society of Civil Engineers, and the separate report of the American Concrete Institute were carefully studied and compared and the provisions included in the code combine the best that are found in both of these reports. The new code allows higher stresses on the concrete than those usually employed. The extreme fibre stress in bending is permitted to reach 800 pounds per square inch, in compression in columns 650 up to 850 pounds per square inch, depending on the type of horizontal reinforcement, and in shear up to 150 pounds per square inch.

In order to use these high stresses, however, it is necessary to use a concrete having a mixture of one part cement to not more than two parts of sand and four parts of crushed stone, and which concrete will show under test a crushing strength of at least 2,200 pounds per square inch at the age of 30 days. In case it is impossible to obtain a 1-2-4 concrete having this strength a richer concrete shall be used or the working stress reduced. Also all materials, cement, sand and reinforcement are subjected to rigid tests. In addition to this, the code provides that all concrete work shall be inspected continuously during the placing of reinforcement, the pouring of the concrete and the stripping of forms.

The writer has studied many other codes and also has discussed the reinforced concrete section with several engineers directly connected with the building departments of other cities or indirectly deeply interested in the subject, and with them he believes that by adopting this code Hartford will have the most complete and up-to-date reinforced concrete provisions of any city in the United States.

The importance of exits from buildings as a means of reducing the danger to life in case of fire is fully realized and the requirements for stairways, fire exits and other exits are explicit and complete.

Elevators and their equipments are subject to the examination and approval of the supervisor before they may be put in operation and once every three months thereafter. Instead of these tri-monthly examinations by his own department, the supervisor may accept the report of inspection of other reliable and properly constituted authorities, which in his judgment are competent and satisfactory.

During one week last summer, there were issued permits for the construction of forty garages, chiefly of light frame construction. It is readily seen that the continued construction of these light frame garages in thickly settled sections of the city will create a hazard of no small proportions. The code has not, of course, eliminated the frame garage, but has, under certain conditions, insisted on certain fire-resistive features, as for instance, plaster board, or metal lath and plaster applied on the inside or on the outside, or in some cases, fire doors, fire windows and fire walls if the frame garage is so placed as to be a fire hazard.

The installation and operation of motion picture machines is clearly provided for and if the provisions are lived up to there should be no danger to life nor to the building in case a film should ignite while outside its container.

Theaters and other places of amusement are fully provided for. Some of the provisions may seem severe, but it was felt that such buildings should be especially well constructed in view of their occupancy and because of the many holocausts in theaters during the past ten years.

Regulations covering the installation of plumbing systems and electric wiring systems have been completely revised and brought up-to-date. They are in accordance with modern practice and are concise and adequate.

The adoption of the new code will, it is believed, put Hartford in the class of the most progressive and up-to-date cities. The average loss per fire in Hartford is high, but the number of fires and average loss per capita is moderate. Hartford is developing a very adequate water supply; many changes and improvements are being made in an already good fire department; a new fire alarm system has been authorized. These will help to prevent a serious fire and will reduce the loss per fire. There is need of better buildings and a reduction in many hazardous features of these buildings to reduce the number of fires and to help prevent the spread of a fire which has once gained headway. This will be accomplished, the writer believes, by the adoption of the proposed code.

DISCUSSION.

Mr. Saunders: Do I understand that a stress of 800 lbs. would be allowed for concrete to apply to floors in warehouses under steady load?

Mr. Mylchreest: Yes.

Mr. Saunders: The reason I ask that is because the tests made by the Department of Agriculture at Washington, at least according to their bulletins, demonstrate that if concrete, 1–2–4, is stressed more than 600 pounds, there will be a constant deflection, increasing with age. They have recently published quite a lot of information to that effect, proving that 600 pounds ought to be approximately the limit, if you are going to have a steady load. If the load is applied for only short intervals that criticism would probably not apply.

Mr. Bilderbeck: What provision is there for setting concrete in cold weather?

Mr. Mylchreest: The details are very carefully provided for. Heating shall be used to keep the temperature of the concrete at a temperature of 40 degrees or higher, for a length of time depending on the outside temperature.

Mr. Bilderbeck: Are there provisions for the wetness of the mixture?

Mr. Mylchreest: It is specified that the consistency shall be such as to flow sluggishly into the forms and around the reinforcing bars.

Mr. Bilderbeck: I had an interesting experience with wet concrete. We put concrete into heavy forms, put it in rather dry. We took samples, six inch cubes; several of them ran between 2,500 and 3,500 pounds compression stress per square inch. Within a few weeks our concrete sluiced in to forms through a shute. We took some cubes, and are getting about 1,400 now per square inch. That is partly due to the cold weather, partly due to water. I wonder if anybody else has had any experience with sloppy concrete!

MR. SAUNDERS: The Association of Portland Cement Manufacturers has recently gotten out some very valuable information on that matter. Their headquarters are in Chicago. They have recently made a large number of tests, in which the consistency of the concrete is the principal thing they are searching for, proving that an amount of water, which is approximately 25 per cent less than that customarily used, in what we call a sloppy mixture, will increase the compressive strength a great amount. They have issued a large number of bulletins; and they are making a series of tests covering a large number of experiments. The information is of great value to any one who is using concrete to any extent.

HARTFORD PAVEMENTS.

By Robert J. Ross, Assistant City Engineer, Hartford, Conn., Member Conn. Soc. C. E.

I have been asked to say a few words in regard to the records which the Department of Engineering of the City of Hartford maintain of improved paved streets in this city. By improved pavements is meant those other than macadam having hard surfaces and with cement concrete foundations.

Since, however, it is first necessary to have the pavements before there is anything to record, I intend to explain briefly the preliminary steps and some of the work which falls upon the Department in connection with laying the pavements.

The start toward paving any particular street is really made the year previous when the Board of Street Commissioners picks out the streets to be paved. A tentative list is first prepared which names the streets, defines the limits of the paving and gives the length to be paved. The statement of the length to be paved is essential since the amount of improved pavement which the city can lay in any one year regardless of the wishes of the property owners is limited by statute to four miles; there being a further provision, however, which permits the laying of two miles of concrete roadways assessable under certain conditions.

Hearings are set and all property owners affected by the paving of the streets are notified by advertisements in the newspapers and by letter to meet with the commissioners at the stated time to discuss the question of the proposed paving. As a result of these hearings, changes may or may not be made in the original programme and the list is then sent to the Court of Common Council with the recommendation that it be approved and adopted.

The Board of Street Commissioners also recommends the type of pavement, but the Court of Common Council may disregard this and substitute another type of pavement if they find it advisable to do so.

When speaking of the type of pavement, I might say that as far as Hartford is concerned this ordinarily means sheet asphalt except on business streets having grades in excess of four per cent where granite blocks on a concrete base with cement-filled joints are generally used.

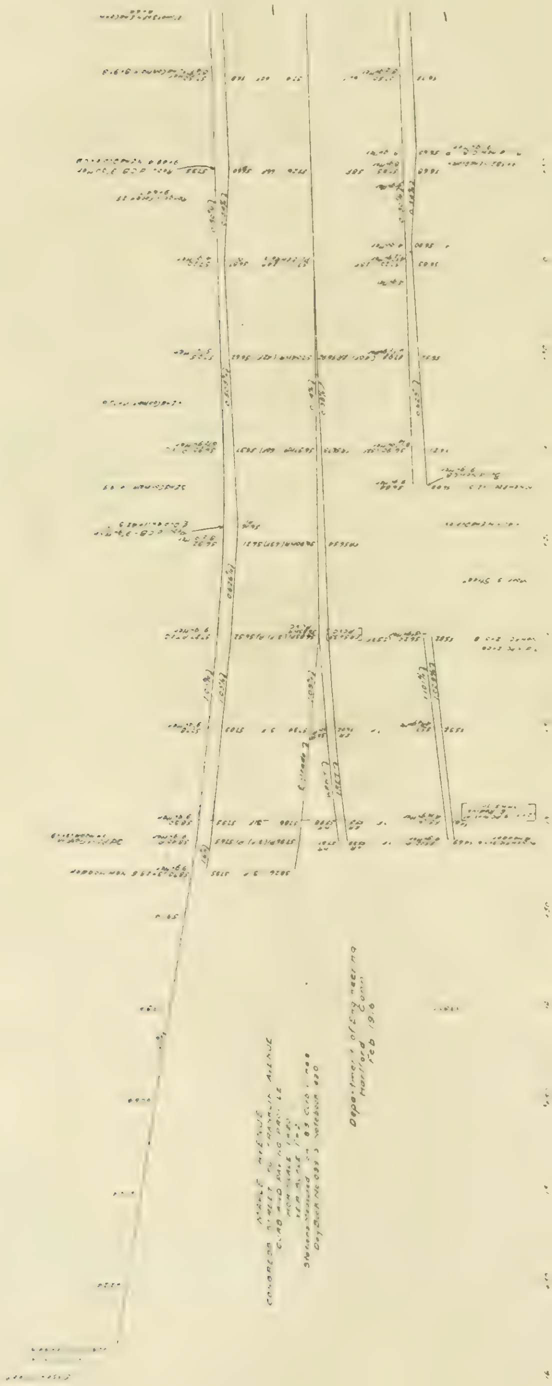
After the streets to be paved are decided upon, a study is made to determine whether or not the wires of the various public service corporations are provided for by underground conduits. For this purpose so-called underground maps are prepared to a scale of twenty feet to the inch. Such a scale makes it necessary to have a large number of individual maps but, on the other hand, with a smaller scale it would prove difficult or impossible to show clearly all of the details necessary. These records are made on tracing cloth and the adoption of a color scheme whereby the lines of the different companies are always shown by a certain color makes them clearer than would otherwise be the case.

A little later, a section of a typical underground map will be shown on the screen at which time the details can better be explained.

When the investigation discloses the fact that there is no underground service for a certain company, a location is worked out for them and a comprehensive development of the sub-surface mapped out to best serve the needs of all parties concerned. By law, the city may order each public service corporation maintaining overhead wires to place not more than two miles of these wires in underground conduits each year. The companies may find it necessary to construct duct lines in excess of two miles in order to accommodate the new pavements which they usually prefer to do rather than be put to the expense of replacing the pavements for the installation at some later date.

Several months previous to the laying of the pavement, all public service corporations as well as all abutting property owners are notified by mail to install any contemplated new work or to repair any existing services before a certain date. This with an object to have all such work out of the way before starting in on the paving of the street and to prevent, as far as possible, the tearing up of the pavement for such purposes after it is laid.

I would like to say a word here in regard to cutting into improved pavements and principally in justification of it, for it is hardly necessary to speak in condemning terms of such action since this would be infringing on the privilege of the public. I must admit, however, that I could cite cases where with proper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foresight on the part of the parties responsible, it would not have been necessary to tear up streets so soon after they had been put in first class condition, and such cases should not be dealt with lightly. In fact, I would suggest that when a request to cut the pavement is received which is directly traceable to carelessness or indifference on the part of those making the request, that a fee be charged in addition to the cost of restoring the pavement sufficiently large to act as a costly reminder against the likelihood of a recurrence of such poor management.

Most of the cutting into the pavement, however, is along lines of improvements which the people and the city demand and which should be encouraged and not blocked by an arbitrary ruling against opening the streets for a stated number of years after a new pavement is finished. Unexpected and rapid growth of a city requires enlarging of mains and services and it would be a poor business move and the height of folly to block such growth by a too conservative regard for a pavement.

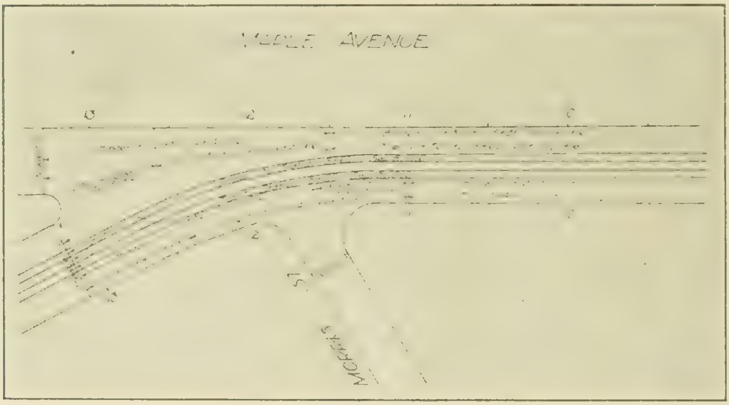
I might give a simple example where it would be desirable and from the city's standpoint advisable to cut into a new pavement soon after it was laid. Let us consider, if you will, an old structure on a main street, one which, perhaps, had been owned by the same party for a long period of years. Notices were sent to this owner advising him that if he contemplated any improvements to his property which would involve excavating in the street that the work would have to be done before a stated time. This party advised with the best of faith that no changes were proposed and then, unfortunately for the pavement, he died.

The result as far as the effect on the street was concerned was that the new proprietor decided to remove the old building and to build in its place a structure worth thousands where the old one was worth hundreds with the same ratio of return to the city in taxes. To refuse the new owner the privilege of opening the street for the necessary services would result in blocking the healthy and desirable growth of our business streets.

This example is not far fetched and is only an indication of the legitimate reasons for cutting into a pavement. It is a fact that outside of emergency breakdowns, more often than not the opening of a street is for an improvement to the city at large and an indication of progress and growth rather than the result of the inefficiency of the city's management as at times from hasty criticism it might appear.

I wonder how many of you who have not been directly concerned appreciate the magnitude of work involved in the paving of a city street, its complexity and the difficulty of confining the operation within short limits. I will take, for example, a street which we paved a year ago as typical of the conditions obtaining in work of this nature. In the first place, I would state that very often the actual laying of the pavement itself is but the finishing touch to the work, although it may be the most conspicuous feature.

In the street referred to, new sewers were built, new water mains laid, new gas mains installed, duct lines built by the Electric Light Company, by the Telephone Company and by the Street Railway Company. Fences were set back and steps rebuilt in a section where the street was widened.



In the case of the sewer, the water, the gas, the electric light and the telephone, either new services were laid to serve each property or existing laterals were repaired.

The roadway was widened which required the relaying of all curbs and walks and the relocating of all poles, hydrants and fire-alarm boxes and necessitated the removal of many trees which previously stood between the curb and the walk. All catch basins were rebuilt and many new ones installed, and at all intersecting streets the curb corners were cut back to larger radii varying from twelve to twenty-five feet.

The single street railway track was removed and new double tracks laid in accordance with the standard construction for Hartford which, by the way, is one of the most thorough and expensive used in this country. A slide featuring this construction will be shown later.

I have mentioned these main items for the purpose of emphasizing the magnitude of the work involved and the number of separate parties concerned.

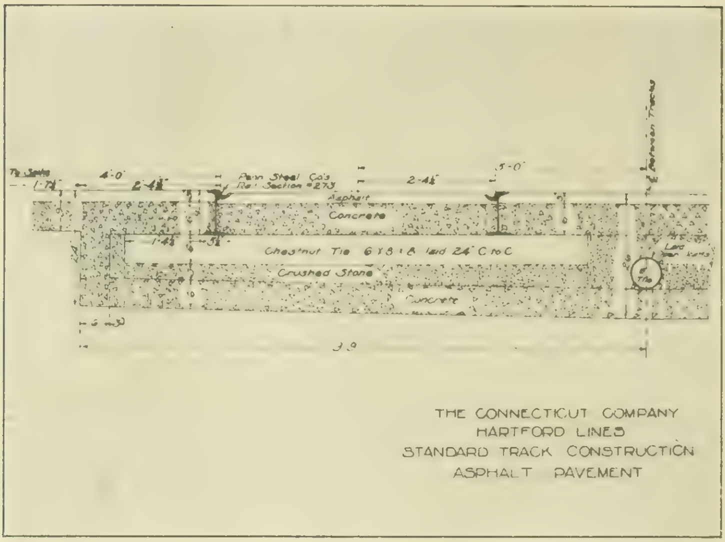
All this construction, preliminary to the paving, is necessary and must precede the actual laying of the pavement. The work incident to the paving of this street which is only nine-tenths of a mile in length, involved the digging of nine and six-tenths miles of trenches by all parties concerned exclusive of the excavating for the pavement itself.

It becomes evident that all this work cannot be carried on in restricted areas if it has to be done in one short season. Where considerable underground work is called for, a two year program should be arranged whereby most of the preliminary work would be ordered done one year in advance of the laying of the pavement. This would allow for a thorough settlement of the trenches before the pavement is laid and would insure its completion of the improvement in seasonable weather—both very serious and essential factors affecting the quality of the pavement.

By such a plan, the work would extend over two seasons but, because of this fact, there would be no necessity for all parties to be working at once and it should be possible ultimately to complete the improvement without at any time closing the street for as long a distance as is now necessary under the present methods of procedure.

As further proof that the paving of a street may be only an incident in the improvement, I would again call your attention to the fact that in the case of the street cited which was only 4,400 feet long, the length of trenches dug totaled 50,435 lineal feet, and while the pavement proper, from curb to curb, cost but $41,049, the entire cost of the work was five times this sum or $205,836 which figure does not include damages caused by widening the street and changing the grade.

Some cities do very little engineering in connection with the paving of a street and, in fact, in many cases such important matters as the gutter grades and cross sections of the surface are left to the contractor's foreman. If one were sure of always


4-0"
1-7½"
2-4½"
Penn Steel Co's
Rail Section #273
Asphalt
5-0"
2-4½"
Concrete
1-4½"
5½"
Chestnut Tie 6 X 8 x 8 laid 24" C to C
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Concrete
6" Tile
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THE CONNECTICUT COMPANY
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STANDARD TRACK CONSTRUCTION
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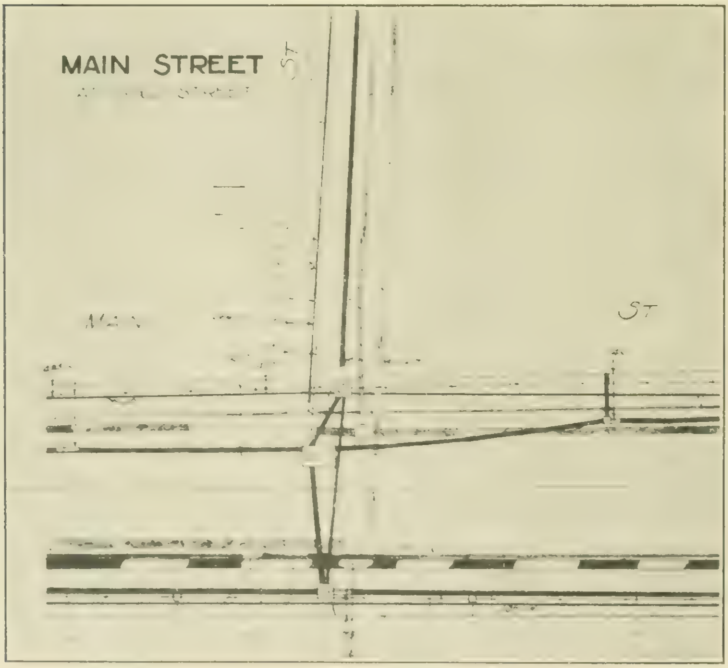
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having the same foreman, and, if he were clever, this situation would not be so bad, but in Hartford we believe in engineering the job from start to finish and all grade stakes are set by our men and the contractor is required to work to them.

We consider that the paving of a street presents an excellent opportunity to improve the lines and grades of the roadway and if, after a thorough investigation, such improvement is shown to be desirable we do not hesitate to make radical and sweeping changes at such times. All of this investigating is done in the winter months and, long before the street work actually begins, the entire improvement is worked out on paper and construction blue prints are made ready for use when work starts.

A little later I will show one of these paving profiles on the screen, at which time it can better be explained.

We believe that a record of the behavior of the pavements after they are laid is as important as the work of building them and in this connection certain tables have been devised which are kept up to date and present much valuable data which is always at hand when needed. The tables are five in number.

Table No. 1 gives a complete history of the pavements from the date the first so-called permanent pavements were laid in Hartford down to the present time. This is valuable as an authentic record of the changes which have taken place on the various streets and of the sequence of paving surfaces.

Table No. 2 is a statement of the existing pavements at the date stated. This table names the streets, the kind of pavement, the yardage of same and the length in miles.

Table No. 3 shows the number of square yards of pavements laid yearly since the first pavements were built and designates the type of pavement. This is valuable in showing the activity of the city in regard to laying pavements in different years.

Table No. 4 names the sheet asphalt streets and states the kind of asphalt used. This is important in comparing the wearing qualities of the various asphalts.

Table No. 5 is perhaps one of the most valuable and interesting. This table shows the cost per yard for repairs to sheet asphalt pavements on streets for each year after the expiration of the guarantee period corrected to date.

These tables present the facts and eliminate all necessity for guess work when discussing the expense and adaptability of the various pavements on Hartford's streets.

If a section of asphalt pavement should go bad, we mean to know why and for this purpose so called progress maps are prepared and placed on file. These maps show the actual location to scale and by station of each day's run of pavement and gives the date when the same was laid. A reference to the plant inspector's daily report will give all information as to the mixture, brand of asphalt, penetration, temperature, etc., so that if any step should prove bad practice, a repetition may be avoided.

In order that the expiration of a guarantee period may not pass unnoticed, a diary is prepared each year wherein the dates on which the guarantee expires are recorded and a warning reference to this date is noted some weeks in advance. The object of this being to insure that the pavement may be gone over and any necessary replacements ordered previous to the expiration of the guarantee since after such dates all repairs ordered would be at the expense of the city and would not fall on the contractor where they rightly belong.

No half hour talk on pavements can hope to be complete and there are many phases of the subject that have not been mentioned, but I trust that I have brought out some points which may be of general interest to all and of special interest to many.

DISCUSSION.

Mr. Hamlin: Have you any data showing the comparison of original cost and maintenance as between the different materials?

Mr. Ross: In regard to the cost and permanency there is no question but that a granite block pavement on a concrete foundation with cement-filled joint is more economical in the long run. It isn't always a question of economy. A great many times it is a question of adaptability. Here in Hartford we are unfortunate enough to have most of our pavements rest on a clay soil. We have it about as hot as any city in the summer, and, generally, we have it about as cold as most in the winter. The frost effect with our clay soil is severe. We find that the asphalt pavement, due to its non-rigid nature, will adapt itself to a great many movements

TABLE No. 1. RECORD OF IMPROVED PAVEMENTS IN HARTFORD TO JANUARY 1, 1916.

Street	Location	Description	Kind	Tracks	Price per sq. yd.	Assessment per front ft.	Final Payment	Guarantee expires
Albany Avenue	Windsor Ave. to East St.	Paved	Sheet Asphalt	D. T.	$2.51	$2.1002	Nov. 12, 1900	Nov. 12, 1905
Albany Avenue	Tunnel to East St.	North side and tracks resurfaced	Sheet Asphalt	D. T.	1.65	By City	Dec. 4, 1909	Dec. 4, 1914
Albany Avenue	East St. to 50 feet East of Magnolia St.	Paved	Sheet Asphalt	D. T.	1.69	2.8845	Nov. 21, 1914	Nov. 21, 1919
Allyn Street	Trumbull St. to Union Pl.	Paved	Sheet Asphalt	No	2.56	3.5590	June 12, 1899	June 12, 1904
Amer. & Cent. Rows	East of Post Office	Paved	Block Asphalt	D. T.	3.04	5.5600	Oct. 12, 1896	Oct. 12, 1901
Amer. & Cent. Rows	East of Post Office	Repaved	Granite Block	D. T.	3.79	By City	Dec. 1, 1909	Dec. 1, 1910
Ann Street	Asylum St. to Allyn St.	Paved	Sheet Asphalt	No	2.56	2.7908	Oct. 10, 1898	Oct. 10, 1903
Asylum Street	Spruce St. to Farmington Av.	Paved	Granite Block	D. T.	3.09	6.1030	Nov. 14, 1898	July 14, 1899
Asylum Street	Spruce St. to Farmington Av.	Tracks relaid	Granite Block	D. T.	....	......	1911	....
Asylum Street	Main St. to Ford St.	Paved	Block Asphalt	S. T.	3.14	2.8680	Nov. 8, 1897	Nov. 8, 1902
Asylum Street	Spruce St. to Farmington Av.	Paved	Sheet Asphalt	D. T.	2.75	6.1030	Nov. 14, 1898	Nov. 14, 1903
Asylum Street	Ford St. to Spruce St.	Paved	Block Asphalt	D. T.	3.14	4.8955	Sep. 26, 1898	Sept. 26, 1903
Asylum Street	Main St. to Spruce St.	Repaved	Sheet Asphalt	S. & D.	2.28	By City	Oct. 12, 1908	Oct. 12, 1913
Asylum Street	Spruce St. to Garden St.	N. side resurfaced	Sheet Asphalt	D. T.	1.27	By City	July 23, 1912	July 23, 1917
Asylum Street	Spruce St. to Hopkins St.	S. side resurfaced	Sheet Asphalt	D. T.	1.27	By City	July 23, 1912	July 23, 1917
Asylum Street	Hopkins St. to Farmington Av.	S. side resurfaced	Sheet Asphalt	D. T.	1.39	By City	Dec. 5, 1913	Dec. 5, 1918
Asylum Street	Garden St. west to Header	N. side resurfaced	Sheet Asphalt	D. T.	0.89	By City	June 23, 1914	June 23, 1919
Atheneum Street	Prospect St. to Main St.	Paved	Sheet Asphalt	No	2.49	1.3350	Nov. 9, 1896	Nov. 9, 1901
Atheneum St. South	Main St. to Prospect St.	Paved	Sheet Asphalt	No	1.60	By City	Nov. 2, 1915	Nov. 2, 1920
Broad Street	Bridge over Park River	Paved	Sheet Asphalt	No	....	......	1897	....
Broad Street	Bridge over Park River	Resurfaced	Sheet Asphalt	No	0.89	By City	June 1, 1914	June 1, 1919
Capitol Avenue	Lafayette Street to Park River	Paved	Sheet Asphalt	D. T.	1.90	1.8393	Nov. 26, 1900	Nov. 26, 1905
Capitol Avenue	Lafayette Street to Broad St.	N. side resurfaced	Sheet Asphalt	D. T.	1.65	By City	July 11, 1910	July 11, 1915
Capitol Avenue	Lafayette Street to Broad St.	S. side resurfaced	Sheet Asphalt	D. T.	1.27	By City	Oct. 4, 1911	Oct. 4, 1916
Capitol Avenue	Broad St. to Park River	Both sides resurf'd	Sheet Asphalt	D. T.	1.27	By City	Oct. 4, 1911	Oct. 4, 1916
Capitol Avenue	Park River to Laurel St.	Paved	Sheet Asphalt	D. T.	2.71	2.2816	Nov. 10, 1909	Nov. 10, 1914
Capitol Avenue	Bridge over Park River	Paved	Brick Block	S. T.	....	......	1895	....

TABLE No. 2. IMPROVED PAVEMENTS IN HARTFORD, JANUARY 1, 1916 (*Continued*).

Street	Location	Tracks	Sheet Asphalt Sq. Yds.	Granite Block Sq. Yds.	Asphalt Block Sq. Yds.	Brick Sq. Yds.	Wood Block Sq. Yds.	Length in Miles
Laurel Street	Bridge over Park River	S. T.				411.00		0.02
Lewis Street	Pearl St. to Gold St.	No	1085.00					0.10
Main Street	Wyllys St. to Windsor Ave.	D. T.	56414.27					1.47
Main Street	State St. north	D. T.					500.00	0.06
Market Street	State St. to Morgan St.	S. T.	5255.28					0.25
Market Street	Morgan St. to Pleasant St.	No	2846.4					0.17
Marsh Court	Market St. to Village St.	No	552.95					0.08
Morgan Street	Market St. to Main St.	S. T.		1520.87				0.10
Morgan Street	Market St. to Front St.	S. T. & D. T.	2213.94					0.09
Morgan Street	Intersection of Front St.	D. T.		342.71				....
Mulberry Street	Main St. to Wells St.	No	1298.85					0.08
Park Street	Under Railroad Bridge	D. T.		560.00				0.03
Park Street	Bridge over Park River	D. T.	555.50					0.02
Pearl Street	Main St. to Ford St.	D. T.	8188.50					0.32
Pleasant Street	Winthrop St. to Main St.	No	1010.41					0.07
Pleasant Street	Windsor St. to Railroad	No	2239.71					0.14
Pratt Street	Main St. to Trumbull St.	No	1438.00					0.11
Prospect Street	Atheneum St. to Central Row	No	1802.62					0.13
Sheldon Street	Main St. to Commerce St.	No	5640.26					0.35
Spruce Street	Asylum St. to Church St.	No	2286.00					0.12
Spruce Street	Church St. northerly	No		1527.82				0.09
State Street	City Hall to Main St.	D. T.	1395.00					0.04
State Street	Front St. to Conn. Boulevard	D. T.	2609.94					0.09
State Street	Front St. westerly	D. T.	343.10					....
State Street	Front St. to City Hall	D. T.		4501.81				0.15
Talcott Street	Market St. to Main St.	No		950.42				0.19
Talcott Street	Market St. to Main St.	No	340.20					....
Talcott Street	Market St. to Front St.	No	1279.1					0.09
Temple Street	Market St. to Main St.	No	1051.87					0.09

TABLE No. 3, SHOWING THE NUMBER OF SQUARE YARDS LAID YEARLY AND THE MILEAGE ACTUALLY COVERED OF THE DIFFERENT KINDS OF IMPROVED PAVEMENT LAID IN HARTFORD SINCE 1892. THIS TABLE INCLUDES ONLY NEW PAVEMENT LAID—NO REPAIR WORK.

Year Laid	Brick		Block Asphalt		Granite Block		Wood Block		Sheet Asphalt		Total Yardage Laid Each Year	Total Miles
	Yardage	Miles	Yardage	Miles	Yardage	Miles	Yardage	Miles	Yardage	Miles		
1892......	1427.55	0.11	....	....	....	....	......	....	....	....	1427.55	0.11
1894......	411.00	0.02	....	....	3267.00	0.12	......	....	....	....	3678.00	0.14
1895......	442.60	0.03	7755.50	0.32	....	....	......	....	....	....	8198.10	0.35
1896......	....	....	12063.32	0.38	....	....	......	....	21466.71	0.63	33530.03	1.01
1897......	....	....	6694.04	0.36	....	....	......	....	45074.48	1.51	51768.52	1.87
1898......	....	....	8925.19	0.32	9148.10	0.40	......	....	21974.39	1.11	40047.68	1.83
1899......	....	....	....	....	560.00	0.03	......	....	63784.40	3.10	64344.40	3.13
1900......	....	....	....	....	....	....	......	....	23923.34	1.06	23923.34	1.06
1903......	....	....	....	....	....	....	600.00	0.06	8188.50	0.32	8788.50	0.38
1908......	....	....	....	....	1756.94	0.07	......	....	13010.10	0.58	14767.04	0.65
1909......	....	...	....	....	4629.87	0.12	......	....	7805.60	0.28	12435.47	0.40
1910......	....	....	....	....	....	....	......	....	14487.97	0.50	14487.97	0.50
1911......	....	....	....	....	....	....	442.60	0.03	10963.41	0.50	11406.01	0.53
1912......	....	...	....	....	....	....	......	....	10583.97	0.58	10583.97	0.58
1913......	....	....	....	....	2108.70	0.10	......	....	9589.89	0.57	11698.59	0.67
1914......	....	....	....	....	....	....	......	....	23889.20	0.98	23889.20	0.98
1915......	....	....	....	....	1096.40	0.05	......	....	29873.30	1.05	30969.70	1.10
Totals....	2281.15	0.16	35438.05	1.38	22567.01	0.89	1042.60	0.09	304615.20	12.77	365944.07	15.29

NOTE.—The original paving on several streets has been removed and replaced by other pavements, and since this table contains both the original and the present pavement, the totals given here exceed the total yardage and miles in use at the present time as shown in another table.

TABLE No. 4. LIST OF ASPHALTED STREETS—GIVING KIND OF ASPHALT USED AND YEAR LAID.

Street	Location	Asphalt Used	Year Laid
Albany Avenue	South side, Lumber St. to East St.	Trinidad	1900
Albany Avenue	North side and tracks, Lumber St. to East St.	California (Atlas)	1909
Albany Avenue	Both sides and tracks, East St. to 50 feet east of Magnolia St.	Aztec (Mexican)	1914
Allyn Street	Trumbull St. to Union Pl.	Trinidad	1899
Ann Street	Asylum St. to Allyn St.	Trinidad	1898
Asylum Street	Main St. to Spruce St.	Bermudez	1908
Asylum Street	Strips on both sides, Spruce St. to Garden and Hopkins Sts.	Bermudez and California (Atlas)	1912
Asylum Street	Strip on north side, Garden St. westerly to header at macadam	Aztec (Mexican)	1914
Asylum Street	South side, Hopkins St. to Farmington Ave.	Bermudez and 5% California	1913
Atheneum Street	Prospect St. to Main St.	Trinidad	1896
Atheneum St. South.	Main St. to Prospect St.	Aztec	1915
Broad Street	Bridge over Park River	Bermudez and 5% California	1914
Capitol Avenue	Both sides, Park River Bridge to Laurel St.	Bermudez	1909
Capitol Avenue	North side, Hungerford St. to Lafayette St.	Bermudez	1910
Capitol Avenue	South side and south track, Broad St. to Lafayette St.	Bermudez	1911
Capitol Avenue	North track and dummy, 150 east of Oak St. to Lafayette St.	Bermudez	1911
Capitol Avenue	Both sides, Broad St. to Park River Bridge	Bermudez	1911
Capitol Avenue	Tracks, Park River Bridge to Laurel St.	California (Atlas)	1909
Capitol Avenue	North side, Hungerford St. to Broad St.	California (Atlas)	1910
Capitol Avenue	Intersection at Lafayette St.	California (Atlas)	1911
Central Row	Main St. to granite block	Bermudez (small area California)	1909
Church Street	Main St. to Trumbull St.	California (Atlas)	1909
Church Street	Union Pl. to Spruce St.	Bermudez and 5% California	1913
Church Street	Intersection at Spruce St.	Trinidad and Bermudez, 50 and 50%.	1913
Farmington Avenue.	South track and dummy, Sigourney St. to Woodland St.	Bermudez	1909
Farmington Avenue.	Woodland St. to 100 feet east of Tremont St.	Bermudez	1910
Farmington Avenue.	South side, south track and dummy, from 110 feet east of Tremont St. to 120 feet west of Beacon St.	Bermudez and Trinidad	1911
Farmington Avenue.	North side and north track, from 110 feet east of Tremont St. to 140 feet west of Beacon St.	California and Bermudez	1911
Farmington Avenue.	From 120 feet west of North Beacon St. and from 140 feet west of North Beacon St. to City Line, both sides	California (Atlas)	1911
Farmington Avenue.	North track, Sigourney St. to Woodland St.	California (Atlas)	1909

TABLE No. 5, SHOWING COST PER YARD FOR REPAIRS TO SHEET ASPHALT PAVEMENT ON TYPICAL STREETS OR SECTIONS OF STREETS FOR EACH YEAR AFTER THE EXPIRATION OF GUARANTEE TO JANUARY 1, 1916.

Street	Section	Yards City only	Completed	Years Guaranteed	Sixth Year	Seventh Year	Eighth Year	Ninth Year	Tenth Year	Eleventh Year	Twelfth Year	Thirteenth Year	Fourteenth Year	Fifteenth Year	Sixteenth Year	Seventeenth Year
					$	$	$	$	$	$	$	$	$	$	$	$
Allyn Street	Trumbull St. to Union Place	6041	1899	5	.003	.02	.02	.03	.07	.02	.06	.08	.04	.04	.043	...
Ann Street	Asylum St. to Allyn St.	1170	1898	5	....	....	....	....	.006	....	.005	....	.01	.01	.01	....
Capitol Avenue	Park River to Laurel St.	2059	1909	5	....	....	....	....	....	....	....	....	....	....	....	....
Church Street	Main St. to Trumbull St.	1399	1909	5	.008	....	....	....	....	....	....	....	....	....	....	....
Gold Street	Main St. to Lewis St.	1458	1898	5	...	....	....	....	....	....	....	.02	.02	....	.01	.006
Grove Street	Main St. to Prospect St.	913	1898	5	....	....	....	....	.04	.06	.06	.03	.12	.14	.07	.049
Hopkins Street	Broad St. to Asylum St.	3136	1899	5	....	.07	.09	.24	.12	.22	.17	.13	.07	.11	.067	....
Kinsley Street	Main St. to Market St.	1037	1898	5	....	....	....	....	....	.06	....	.01	....	....	.01	.005
Lewis Street	Pearl St. to Gold St.	1085	1900	5	....	....	....	....	....	.01	.02	....	.01	.009	....	....
Mulberry Street	Main St. to Wells St.	1299	1898	5	...	.02	....	.02	.04	.01	....	.02	.03	.05	.07	.004
Pearl Street	Main St. to Ford St.	4581	1903	10	...	....	....	....	....	.03	.011	....	....	....	....	....
Pleasant Street	Main St. to Winthrop St.	1010	1898	5	.01	....	....	....	....	....	.05	.01	...	....	.01	.016
Pratt Street	Main St. to Trumbull St.	1438	1899	5	.01	.003	.01	.06	.05	.04	.03	.05	.13	.05	.046	....
Spruce Street	Asylum St. to Church St.	2286	1900	5	....	....	....	.002	.002	.01	.02	.05	.05	.051	....	....
Temple Street	Main St. to Market St.	1052	1898	5	.003	.006	....	...	....	....	.01	....	....	.03	.001	.003
Trinity Street	East side, Pearl St. to Capitol Ave.	2000	1908	5	....	....	....	....	....	....	....	....	....	....	....	....
Village Street	City Park to Pleasant St.	1927	1899	5	....	....	....	....	....	....	.005	.03	.02	.01	.016	....

in the concrete base without any detrimental effect from which another and harder pavement would suffer. We have found that in a great many streets, where there were no breaks in the asphalt pavement itself, there were cracks in the concrete foundation when the top was stripped off. I don't believe a brick pavement, for instance, would do as well under these conditions as the asphalt. It is a question really of the conditions you meet. In Hartford we happen to have an asphalt plant located right in the city. That is a great asset. I think a small city could not make a greater mistake than to lay sheet asphalt unless there is an asphalt plant handy. You can easily repair wood block or brick, but an asphalt repair job is quite an operation. There is no money in it for the companies and they are not anxious to make a trip to a small place to make the repairs where the whole job amounts to but a comparatively small sum.

In Hartford I believe asphalt has done very well. It is adaptable to our conditions, but I think asphalt has no place in a small town.

Mr. Peck: From this information kept by the Engineering Department in the form which Mr. Ross has shown to you, we are able to obtain some very interesting data of almost any kind for an economical argument, which we sometimes have to make before the Board of Finance. I have recently been before the Board of Finance and have in mind a few figures which are possibly of interest, as to the average cost over a number of years.

Mr. Ross's figures showed the patching cost only, you might say. Of course, if we are going to study the maintenance of an improved pavement we need to consider the costs of all kinds necessary to carry it on indefinitely.

For the ten years, 1906 to 1916, the average annual cost of maintaining, including resurfacing, all the improved pavements (permanent pavements, or improved pavements, as they are called in this city) out of maintenance guarantee, was 14.87 cents per square yard. They covered 9⅓ miles of pavement; some of which were just out of maintenance guarantee at the beginning of the period; others had been out five or six or seven years. At the end of the ten-year period there had elapsed since first laid from twenty-two to twenty-four years in some cases. A very small percentage of that nine miles had been out of guarantee only two or three years. That was about 165,000 square yards outside of the railroad area.

To go a step further, which may be of interest as a comparison between the ultimate cost of improved pavements and water-bound macadam. (I said I could figure out almost any kind of an economical argument.) I haven't been able to figure that improved pavement is more economical than water-bound macadam. Hartford has about 100 miles of water-bound macadam. The average costs of maintaining it are pretty fair since it is spread over almost the entire city, including all thoroughfares, with the exception of a small area in the center. For that same ten-year period the average annual cost per square yard for maintaining the water-bound macadam, including all resurfacing and renewals, was 3.43 cents, as against 14.87 for the improved pavements.

Of course, when we are arguing for improved pavement we have to say that there are other advantages to offset that difference. No one has asked me to prove it yet, but I may have to some day.

Speaking of the water-bound macadam, there is one other point of interest—the cost of maintenance did not increase in those ten years. That is contrary to the general impression, I think. I recall reading that in Massachusetts costs had increased approximately ten times in ten years, which was about the proportion in which automobiles have increased; but that probably referred to state roads, while I am speaking of city streets. The maintenance cost for the first three years of the ten-year period, including all renewals and resurfacing, was 3.40 cents per square yard per year; in the last three years of that period it was 3.17 cents per square yard per year.

In other words, figuring in interest on first cost, improved pavement costs the city of Hartford, annually, for a thirty-foot width, about $6,000 a mile per year; macadam, $1,600 a mile per year.

Mr. Bennett: Getting away from the narrow view of sheet asphalt pavement, there are two things in Mr. Ross's paper which he expressed, one by inference, the other very clearly. The first is in connection with the cuts in pavements. It may seem strange that the State Highway Department should have any difficulty in that matter, but it does; and the inference I drew from Mr. Ross's paper, shows that the difficulties in having underground structures built before the pavement is completed, arise mainly from the diversity of authority in the construction of these underground facilities. I am perhaps more familiar with all the cities of Connecticut than anybody else, because we have business in all of them. There is no standard method in any one of those cities for installing underground services. There is no one authority in any city that can say how and when and where these structures shall be put in. There is room for an enormous amount of criticism in this situation; and I am looking forward to seeing a standard form of charter established for the cities of Connecticut that will fix the responsibility so that better work will result.

The other point is the giving the proper amount of attention to grade before the construction of pavement is actually commenced. There are a great many instances in the state (not in Hartford, for the work is well done here) on the public highways, and in cities where lack of attention on the part of the engineer in laying out grades, has worked almost irreparable damage to the property owner. And I want to take this opportunity to say to the men in my own department that they should pay strict attention to the grades of pavements before the pavements are laid, and not be obliged to come along afterwards and say, "I am sorry I didn't see that before." And I think the same advice would apply to a great many other engineers in the same line of business.

MR. BILDERBECK: I would like to speak with reference to that schedule which Mr. Ross gives. It seems to me that while he gives the total yearly maintenance on those pavements he neglects one thing, in not giving the amount of traffic. In determining the value of a pavement should that not be taken into consideration?

MR. ROSS: I think it should be taken into consideration, and probably, in a complete study, it would have to be. There is the danger in making the tables so complete and detailed that they are complicated, and your facts require too much study to get at them. It is perfectly true that if you wanted to decide what pavement was best adapted to a certain street the traffic would enter into the consideration. It is a fact, however, that some of the streets of Hartford where the traffic is heaviest show up just as well as some where the traffic is much lighter.

Mr. Saunders: Has Mr. Peck any figures showing the cost of upkeep of a piece of macadam as compared with improved pavement, where the traffic conditions are identical or nearly so?

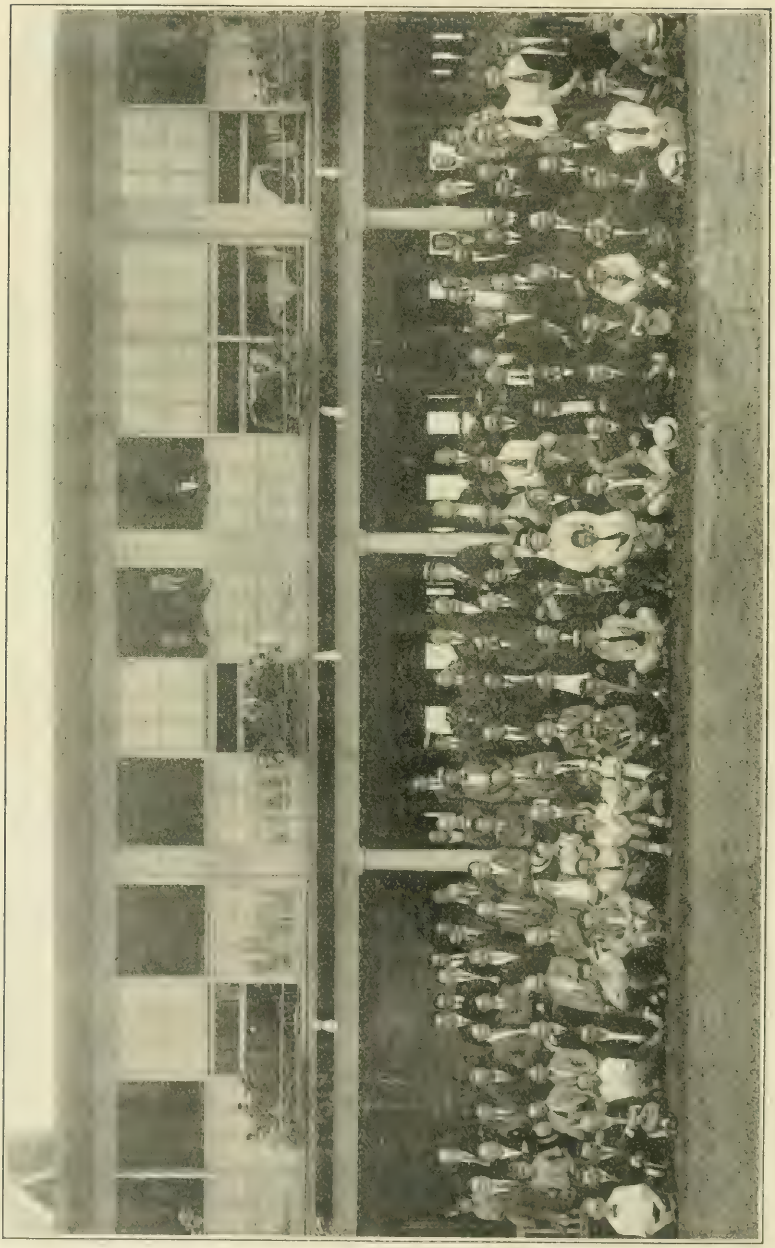
Mr. Peck: I would not say that if you were to put macadam on Main street here it would be cheaper to maintain than improved pavement. Up to the time I started estimating these costs, Hartford was limited by statute to half a mile a year of improved pavement. That means that a good many of the main thoroughfares, Franklin Avenue, Wethersfield Avenue, Windsor Avenue, Albany Avenue, were macadam, and of course carried through, heavy traffic, in addition to the various macadam streets in the center of the city. So that it is a pretty fair test over the thing as a whole.

Mr. Saunders: Wouldn't the upkeep of a particular street run higher by several times than that of the average ten or twenty?

Mr. Peck: Not very much. I haven't those figures in mind with the exception of one section, where we figured the cost of Asylum Avenue maintenance for one year, from Prospect Avenue to the junction with Farmington Avenue. That doesn't necessarily mean very much. We need the figures for several years to mean anything. As I remember it, it was under four cents for Asylum Avenue.

Mr. Saunders: Do the figures given by Mr. Ross include cleaning?

Mr. Peck: No. If we include cleaning we are so much further away, because the cleaning is about three times as much on improved pavement as it is on macadam.



SUMMER MEETING

MOMAUGUIN, AUGUST 8, 1917.

About one hundred and twenty-five members and their friends assembled at the Union Station, New Haven, and proceeded in autos and trolley to Momauguin, at Cosey Beach, where the annual ball game took place, which would have been on yet if the shore dinner which was set for 1.30 P. M. had not drawn most of the spectators and some of the players. After the dinner some availed themselves of a sail on the sound, while others indulged in various sports. The meeting broke up about 4.30 to allow the up-state members present to catch their trains.

The following were elected to membership:

Active—Walter T. Arnold, Meriden; Merwin M. Johnston, New Haven; Edwin T. McDowell, Middletown; Howard E. Phelps, New Haven; Raymond W. Prann, Branford; Henry I. Skilton, Hartford; Philiph S. Strout, Burnside; Henry J. Tippet, New Haven; Edwin F. Poland, West Haven. Associate —Ralph M. Robinson.

Votes of thanks were extended to Chairman Dunham and the committee on arrangements.

WILLIAM HENRY MILLER.

*Mem. Conn. Soc. C. E. Died December 4, 1917.**

William Henry Miller was born at Greenfield, Mass., April 10, 1877, the son of Henry L. and Wanda Miller. He was educated in the Greenfield schools and started his surveying work with Mr. C. J. Day, who had charge of the town work.

For several years he was engaged in other lines of endeavor and in 1898, at the time of the Spanish-American War, enlisted in Company L, 2d Mass. Volunteers. Although he saw no active service, he was sent South to a camp in Florida, where, through sickness, caused by exposure, he was confined in the hospital for several months, later being transferred to a Cincinnati hospital.

In October, 1905, the N. Y., N. H. & H. R. R. Co. decided to double track and consolidate their Highland and Naugatuck Divisions, eliminate all grade crossings, build a union station and run through the City of Waterbury on an elevated right of way. Mr. Miller was one of the first to join the augmented engineering corps of the company and served for a number of years as transitman and inspector of construction on this project, which included the rebuilding of the main lines and the development of freight yards.

Later he was assistant in the land surveying office of Mr. Wm. B. Reynolds of Waterbury, and superintendent for Mr. Wm. Henry White, at his country estate in Middlebury, with both of whom he was engaged for several years.

Mr. Miller had been a member of several organizations, among which were the Massachusetts National Guard, Toantick Tribe, No. 22, Improved Order of Red Men, of Waterbury, Federal Lodge, No. 17, A. F. & A. M., of Watertown, Secretary of Middlebury and Excelsior Pomona Granges, Quartermaster Sergeant, Middlebury Company, Connecticut State Guard, and member Connecticut State Council of Defense from Middlebury.

Recently Mr. Miller had entered industrial plant work as a field engineer for Mr. Hugh L. Thompson at Scovill Manufacturing Company of Waterbury and had been engaged but a few weeks when his health failed as a result of weakness caused by exposure during camp life in 1898.

After a short illness he died on December 4, 1917, at his home in Middlebury.

Mr. Miller was of a quiet and unassuming nature, but a trustworthy, conscientious and thorough worker in any task he undertook. His services were highly valued by his employers and his friendship by his associates.

He married Mary Alice Van Hoesen of Waterbury, who, with his mother, survives him.

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*Memoir prepared by F. J. Trowbridge.

CLARENCE BROWNING VORCE.

*Died February 4, 1918.**

The many friends, and they are legion, of Clarence Vorce were inexpressibly shocked to learn of his death on February 4, 1918, at the Roosevelt Hospital, New York City, after an operation from the effects of which he failed to rally. For some little time he had suffered with failing health and had been forced to withdraw from his professional engagements.

Mr. Vorce was born at Farmington, Connecticut, in 1866, and graduated from the Massachusetts School of Technology in 1888. His first engagements were with the New Haven railroad and the Kearney Land and Improvement Company, Kearney, Nebraska, succeeding which he joined, in July, 1889, the engineering staff of the Lake Shore and Michigan Southern Railroad and was engaged in maintenance of way, changing line and grade, bridge constructions, etc. This work was followed by his return, in February, 1893, to the New Haven railroad, where he was in charge of the field work, designs and estimates in connection with the four-track improvements, masonry structures, re-locations, etc., at and about Stamford, Conn. He remained with the New Haven until August, 1897, when he opened an office in Hartford as a Consulting Engineer. This office was closed in 1906 to join the staff of Sanderson & Porter, New York and San Francisco, with whom he remained to the time of his death, except an engagement as Engineer of the British Columbia Electric Railway Company, Victoria, B. C., where he made a notable record in designs and economical constructions involving large expenditures. With the Sanderson & Porter organization, Mr. Vorce was actively engaged in important railway and hydraulic construction in the far west and in the south, to which was added during the later years a considerable amount of valuation of steam and electric railroad properties.

Mr. Vorce was a member of the American Society of Civil Engineers and joined our Connecticut Society Jan. 10, 1899. He served us as President in the year 1902, and did much to advance the interests of the Society while an officer. To his professional work he brought exceptional ability and sound judgment combined with a vigor of mind and body that always seemed inexhaustible. His polished address and cheery disposition made him a delightful companion and friend.

In 1892 Mr. Vorce married Miss Virginia Osborn of New Haven, who, with a daughter, survives him.

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* Memoir prepared by Edward W. Bush, Henry J. Kellogg and Henry J. Tippet.

PROCEEDINGS

OF THE

THIRTY-FOURTH ANNUAL MEETING

OF THE

Connecticut Society of Civil Engineers

MORNING SESSION—TUESDAY, FEBRUARY 19, 1918.

Meeting called to order at 10.30 A. M. by President Buck.

It was voted to approve minutes of last annual meeting as printed in annual report.

Report of the Board of Direction read by Secretary Jackson.

REPORT OF BOARD OF DIRECTION.

At the meeting held March 26, 1917, at Hotel Taft, New Haven, a committee consisting of Messrs. Buck, Bennett and Elwell was appointed to wait on Governor Holcomb and ascertain his position in relation to making a census of the engineers of the state.

The report of Messrs. Buck, Bush, Trumbull and the Secretary, the committee on census blank, was received and discussed. *Voted*: To adopt form as modified.

Matters of maintaining employment lists and of awarding prizes for papers were discussed. *Voted*: To table them for later consideration.

Voted: To send copies of census blanks to Harvard and Providence Engineering Associations and to the *Engineering News*.

An invitation to send representatives to Engineering Conference at Chicago was received.

Voted: To write, expressing inability to attend.

Resignation of T. P. Hulbert received and accepted.

Matter of smoker, to be held in Waterbury, was discussed and secretary instructed to write and ascertain if local members desire to hold one there.

Present—Messrs. Buck, Dunham, Bennett, Elwell, Blakeslee and Cairns.

At the meeting held at Hartford Golf Club, June 28, the matter of omitting the summer meeting was discussed.

Voted: To hold it at the Momauguin in August, the details to be left to a committee to be appointed by the President.

The question of deceased members in arrears for dues was discussed. It was the sense of the board that dues should not be remitted.

In the opinion of the board, former members of the Society desiring reinstatement should pay all indebtedness up to the date on which they were dropped, before being reinstated.

Resignations of Walter H. Richards, Willis J. Black, and Cyrus P. Howes were received and accepted.

Present—Messrs. Buck, Dunham, Bennett, Elwell, Kellogg, Blakeslee, Cairns and Ross.

At the meeting held August 8, at the Momauguin, applications for active membership of Walter T. Arnold, Meriden; Merwin M. Johnston, New Haven; Edwin T. McDowell, Middletown; Howard E. Phelps, New Haven; Raymond W. Prann, Branford; Henry I. Skilton, Hartford; Philip S. Strout, Burnside; Henry J. Tippet, New Haven; Edwin F. Poland, West Haven, and Ralph M. Robinson, New Haven, for associate, were approved.

Communication from Prof. Hollis in reference to census of engineers received and placed on file.

Three members were dropped from the rolls for non-payment of dues.

Voted: To send notice of remission of dues to enlisted men.

Present—Buck, Dunham, Elwell, Blakeslee, Kellogg and Cairns.

At the meeting held January 21, 1918, at the City Club, Hartford, the ballots for nomination of officers were canvassed with the following result: President, William R. Dunham, Jr.; First Vice President, Charles J. Bennett; Second Vice Presidents, Thomas R. Scott, Alfred H. Terry; Secretary and Treasurer, J. Frederick Jackson; Director, Leon F. Peck.

Voted: That the annual meeting be held in Hartford, that it be a two-days session, the arrangements to be left to a committee to be appointed by the President.

Three members were dropped for non-payment of dues.

The following resolution in relation to men engaged in the service of our country was adopted:

Voted: That annual dues be remitted for all members of this Association who are engaged in the military or naval service of the United States, or who are devoting their whole time and attention to the work of the Red Cross, or the Y. M. C. A., the Knights of Columbus, or similar activities of a patriotic character which compel abandonment of regular occupation and absence from home, remission of dues to be effective for the year during which such service is entered upon, and shall continue until and including the year in which such service shall end.

Applications of Cresson L. Beele, New Haven; Miles G. Blakeslee, New Haven; Herbert E. Brink, New Haven; Aaron Burros, Waterbury; Lawrence J. Carmalt, New Haven; F. Perry Close, Hartford; Edward L. Donaghue, Hartford; Clyde D. Foote, New Haven; Walter P. Green, Waterbury; George S. Frances, Wethersfield; Eben C. Hollis. Waterbury; Frank W. Ineson, Waterbury; Irving C. Miller, Waterbury; Moses A. Wadhams, Hartford; Irville D. Waterman, New Haven; transfer Albert D. Blakeslee, associate to active member, were approved.

Present—Messrs. Buck, Bennett, Dunham, Blakeslee, Kellogg, Cairns and Ross.

A meeting was held February 19, 1918, in Odd Fellows Hall, Hartford.

Present—Buck, Elwell, Kellogg, Blakeslee, Dunham, Bennett, Ross, Jackson.

The resignations of E. F. Lawton of Hartford and Robert P. Lewis of Waterbury were accepted.

The Secretary brought up the matter of members who were in arrears, and who, upon being notified by registered letter, made a partial payment. He had been in the habit of accepting such payments but questioned the wisdom of the practice, and brought it before the meeting for their attention. Frequently the part payment did not bring the member into full standing under the constitution, and the offenders were usually habitual.

After discussion, it was the opinion of the directors that the practice was not constitutional, and that after the receipt of the registered notice upon failure to pay the member ought to be dropped unless some good reason appeared for carrying him.

Applications of Paul E. Goodell and Clyde D. Foote were approved.

H. J. Kellogg,
C. C. Elwell,
C. Blakeslee,
W. R. Dunham, Jr.
Board of Direction.

Attest: J. Frederick Jackson, *Secretary.*

Accepted and placed on file.

Report of the Secretary read by Secretary Jackson.

Report of Secretary.

To the Officers and Members of the Connecticut Society of Civil Engineers:

Your Secretary respectfully submits the following report:

In September, 1,800 copies of the thirty-third annual proceedings were distributed to the members, to those societies with whom we exchange and to different libraries and institutions of learning.

The summer meeting was held at the Momauguin, August 8, and a full account appears elsewhere. In addition, the Society held one smoker at Waterbury, June 16, about forty members being present.

The Secretary has, during the year, attended the different meetings of the Board of Direction, has had printed and distributed notices of the different meetings, bills for dues and advertising, and the ballots for nominations and election of officers. The canvass for nominations of officers resulted as stated in the report of the Board of Direction.

The Board of Direction approved and sent out the following census blanks:

CONNECTICUT SOCIETY OF CIVIL ENGINEERS

At the annual meeting of the Society at New Haven, February 21, 1917, it was voted to prepare and place on file with the Secretary the information requested on the enclosed blank regarding member and non-member Engineers in the State.

The purpose of this census is to have available in convenient form, more complete information than now exists, regarding the special professional qualifications of all Civil Engineers in the State, for the use in any State of National emergency where their services, as Engineers, in civilian capacities might be required by the authorities.

Governor Holcomb has seen the enclosed blank and fully approves of the proposed action of the Society.

Assuming that you desire so to serve your State and Country, you are requested immediately to furnish the information asked for and to send the completed blank to the undersigned. It is also requested that you send the Secretary the names and addresses of as many Civil Engineers in your vicinity who are not members of the Society as you can, in order that these blanks may also be sent to them.

Very truly yours,
J. FREDERICK JACKSON,
Secretary.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS

Census of Member and Non-member Civil Engineers in the State

(Member)
1. Name (in full).......................................(Not a member)
2. By Whom Employed...
3. In What Capacity..
(See no. 15 for details)
4. Business Address, City.........Street and No......................
" Phone, Exch. ....No. ....
5. Home Address, City............Street and No. ....
" Phone, Exch. ....No. ....
Married?
6. (a) Age....Yrs. (b) Height....(c) Weight......(d) Single?......
Widower?
7. How many persons dependent on you for support?..................
8. Is your physical condition such as to permit you to supervise engineering and construction work in the field?......................
9. Are you a citizen of the United States?.....................
10. If not, have you taken out your first papers?......................

11. If not, what is your nationality?....................................

12. Have you ever performed military service or received military instruction or training in this or any other country?......................
Where? ....How long? ....
What branch? ....Rank? ....

13. Are you now a member of any military organization or have you expressed your willingness to so serve? Give details...............
....

14. Can you drive an automobile?....Motorcycle?....Ride a horse?....
Handle a motor boat?.........Sail boat?.........Swim?.........

15. Give a brief statement of your technical education and professional experience, giving dates, location, nature and extent of more important works upon which engaged and in what capacity.
....
....
....
....
....
....
....
....

16. What Kind of Engineering Work are you qualified to design, direct or assist in?
Underline one or more of the following general headings, marking thus (X) the branch in which you are best qualified and have had the most experience. Amplify your choice by other sub-divisions if you desire.

(a) Railroad (steam or electric) construction, maintenance, bridge design, signals, maintenance of equipment, operation, etc.
(b) Water Supply and Sewers, design or construction.
(c) Highway;—Construction and Maintenance.
(d) Steel;—Structural and Bridge Work, design or erection.
(e) Electric Power Stations and Transmission Lines.
(f) Electric Communication, telephone, telegraph, wireless, etc.
(g) Buildings;—Design or Construction.
(h) Wharves, Piers, Tidewater Work, design or construction.
(i) Construction Superintendence. Handling of labor and plant as superintendent or foreman on any of the above. Use of explosives.
(j) Hydrographic Surveying, Harbor work, etc.
(k) Topographic Surveying and Mapping.
(l) Not described above;—

Date ....Signature ....

The Society now has the record of 271 members and 118 non-members of the Society on these blanks in its files.

During the year twenty-two active members have been elected and two associate; sixteen active members have been dropped and four active members have resigned. Two active members, William H. Miller and Clarence B. Vorce, have died. The membership February 19, 1918, is as follows:

	Feb. 20, 1917.	Elected	Resigned	Dropped	Died	Feb. 19, 1918
Honorary	13					13
Active	341	22	4	16	2	341
Associate	21	2				23
	375					377

Accepted and placed on file.

As a Supplementary Report the Secretary read the Honor Roll of the Members of the Society now serving their country, and requested that, if there were members in the service whose names were not read, he be notified in order that the list should be as complete as possible.

This list is printed on page 157.

Report of the Treasurer read by Treasurer Jackson.

REPORT OF TREASURER FOR YEAR ENDING FEBRUARY 1, 1918.

RECEIPTS.

To cash on hand February 1, 1917	$323.72
Received discount on bills for advertising	17.79
Received from advertising, 1916	10.00
Received from advertising, 1917	364.00
Received account of back dues	78.00
Received account of dues, 1916	152.00
Received account of dues, 1917	950.00
Received account of dues, 1918	60.00
Received account sale of dinner tickets	513.00
Received account sale of Society Pins	20.25
Received account sale of Proceedings	12.33
	$2,501.09

DISBURSEMENTS.

By Freight	$ 6.88
Express	5.05
Expenses of annual meeting	434.83
Expenses of summer meeting	257.00
Printing, stationery and supplies	902.08
Rent of Post Office Box	6.00
Society Pins	20.00
Postage	33.00
Engraving	77.90
Stenography and typewriting	112.25
Telephone	.50
Telegrams	1.44

Protested check	$ 4.00
Census	89.90
Salary of Secretary, 1917	200.00
Liberty Bond	100.00
Balance in Bank February 1, 1918	249.60
	$2,501.09

Accepted and placed on file.

Reports of Special Committees.

Mr. Buck reported for the Legislative Committee that at the last session of the Legislature, the committee appeared before the Committee on Appropriations, on behalf of the bill then pending providing an appropriation for the State Park Commission.

Mr. Turner: I would like to acknowledge, on behalf of the State Park Commission, the efforts of the committee. We didn't get what we thought was very much money, but we got powers that we really thought were very important.

Election of New Members.

The Secretary: The following applications have been published in the announcement of the meeting, approved by the Board of Direction and the names of Cresson L. Beeler, New Haven; Miles G. Blakeslee, New Haven; Herbert E. Brink, New Haven; Aaron Burros, Waterbury; Lawrence J. Carmalt, New Haven; F. Perry Close, Hartford; Edward L. Donaghue, Hartford; Clyde D. Foote, New Haven; Paul E. Goodell, Stratford; Walter P. Green, Waterbury; George S. Frances, Wethersfield; Eben C. Hollis, Waterbury; Frank W. Ineson, Waterbury; Irving C. Miller, Waterbury; Moses A. Wadhams, Hartford; Irville D. Waterman, New Haven; for transfer from associate to active members Albert D. Blakeslee—are now before the society for action.

On motion, the Secretary cast one ballot for the above names and the President declared them elected.

Mr. Ferry addressed the Society on the idea suggested by Prof. Breckenridge of a joint meeting of the American Society of Mechanical Engineers, which Society has five branches in the State, at New Haven, Hartford, Bridgeport, Meriden and Waterbury, with the Connecticut Society. After discussion by Messrs. Ferry and Elwell it was voted: that it is the opinion of this Society that such a joint meeting would be advisable, and that the Secretary be instructed, in case an invitation comes to join with them in such a meeting, that he accept for the Society.

Upon motion by Mr. Bush, later amended by Mr. Saunders, and after a particularly full discussion by the president, secretary, Messrs. Bush, Saunders, Kellogg, Elwell, Ryder, Ferry, Bennett and Ross, the following resolution was adopted:

Resolved, That the Society establish a cash prize of ten dollars for the purchase of engineering text books to be awarded each year, by vote of the Society at large, to the paper published in the annual report most helpful to the Engineering profession in general.

Mr. Storrs presented report of canvass of letter ballot as follows:

ELECTION OF OFFICERS.

Total votes cast	109
Thrown out	8

For President.

Wm. R. Dunham, Jr.	98
Thomas A. Scott	1

For First Vice-President.

Charles J. Bennett	97

For Second Vice-President.

Thomas A. Scott	60
Alfred H. Terry	37
J. C. Tracy	1

For Secretary-Treasurer.

J. Frederick Jackson	98

Board of Directors.

Leon F. Peck	92
Charles R. Hart	2
John K. Punderford	1

THE CHAIRMAN: I declare the following officers elected:

President, Wm. R. Dunham, Jr.
First Vice-President, Charles J. Bennett.
Second Vice-President, Thomas A. Scott.
Secretary-Treasurer, J. Frederick Jackson.
Member of Board of Directors, Leon F. Peck.

TUESDAY, FEBRUARY 19—AFTERNOON SESSION.

Address of Welcome—by Mayor Frank A. Hagarty.

Mr. President and Gentlemen of the Connecticut Society of Civil Engineers:

It is a very great pleasure indeed to have the opportunity of welcoming you to the City of Hartford. I am sorry that we haven't a more pleasant day to offer you for your session. I had supposed that engineers were able to do almost anything, but they apparently haven't gotten to the point yet where they can do anything about the weather. We have a fine City Engineer here, and an able corps of assistants, a splendid engineer at the head of our Street Department besides, and other men who belong to your learned profession, who give their time and the value of their accomplishments to the City of Hartford; and I should suppose that they might have done something about it. The fact that they haven't indicates pretty clearly to my mind that that is one of the things that your profession has yet to do.

It is a fact, however, gentlemen, that the various allied branches of your profession are responsible for most of the wonders of this wonderful age. One cannot go about this country, and visit its magnificent metropolitan cities, and see the splendid structures that help to make up the life of those cities; see the splendid highways, well laid out, well paved, well cared for, that are a part of the life of those cities; see all of the various wonders; gigantic machinery; the railroad tracks that link the various parts of the continent together; the magnificent power plants of various kinds; the splendid bridges that span our rivers; all of these things which make such a difference in the physical aspect of the modern world,—one cannot see those things and recognize how much they mean in our modern scheme of life, without adding his tribute to the members of your profession. To the members of your profession more than to the members of any other profession, the things that are remarkable, that are apparent, that are palpable, in this wonderful age in which we live, are due. And you are only at the beginning of the things that are to be.

You meet together, year after year, on occasions of this kind, for the purpose of matching up your ideas one with another; and out of the discussion and thought which is engendered at meetings of this kind you never fail to draw conclusions and deductions which are not only for the benefit and advancement of your profession as a profession, but must necessarily be for the benefit and the advantage of our civilization. So it is a very great pleasure and privilege to welcome you here to the City of Hartford for the holding of this annual convention.

There are many things here that we are proud of. I might take up more of your time than I am entitled to take in boasting of and describing many of the things that the city is proud of; but I will only say that whatever we have here in Hartford, whatever we may be proud of, whatever we may feel inclined to boast of, is yours throughout the period of your stay. We want you to know that you are sincerely welcome. Many conventions come here in the course of the year, but we are always particularly glad to welcome a convention which is made up of men who constitute one of the learned professions of the time; and that is what your profession is. So we are exceedingly gratified, we are flattered, to have you select Hartford as a suitable place for the holding of your convention; and we hope you will be as happy here as we want you to be; and that when you go away you will take such pleasant memories of your visit to the Capital City of Connecticut that you will often select it as the place for the holding of your annual conventions in the future.

Mr. Van Schaack read his paper on "The Opportunities for Safety Engineering in Construction Work."

Paper printed on page 27.

Mr. Mohlman read a paper on "Sewage Experiment Station at New Haven."

Paper printed on page 35.

Mr. Saunders read his paper on "The Derby-Shelton Highway Bridge."

Paper printed on page 52.

Mr. Van Woedtke read his paper on "Safety Engineering and Accident Prevention in General Contracting."

Paper printed on page 60.

WEDNESDAY, FEBRUARY 20.

Mr. Brewer read his paper on "The South Street Cut-Off and Other Sewer Construction in Tunnel."

Paper printed on page 80.

Mr. Mylchreest read his paper on "The Proposed Building Code of the City of Hartford."

Paper printed on page 87

Mr. Ross read his paper on "Forms of Paving Statistics in Use in Hartford."

Paper printed on page 98.

Votes of thanks were extended to Mayor Hagarty and to those presenting papers before the Society, and to the Charter Oak Lodge of Odd Fellows for the use of their hall as a meeting place.

The sympathy of the Society on account of his recent illness and wishes for a speedy recovery were extended to George K. Crandall.

President Buck then turned the meeting over to President-elect Dunham, who announced the appointment of Albert L. Donnelly as Assistant Secretary.

The meeting was then adjourned.

CONSTITUTION.

ARTICLE I.

NAME AND OBJECT.

SECTION 1.—The name of this Society shall be the CONNECTICUT SOCIETY OF CIVIL ENGINEERS.

OBJECT.

SEC. 2.—The object of this Society shall be the professional improvement of its members; the encouragement of social intercourse among men of practical science, and the advancement of engineering in its several branches, to wit: Civil, hydraulic, naval, sanitary, mechanical, electrical, architectural, mining, geological, metallurgical, and chemical; the reading and discussion of papers, or to hear lectures on any of the above topics relating to engineering science, and the transaction of all business properly belonging to said Society.

ARTICLE II.

MEMBERSHIP.

SECTION 1.—The membership of this Society shall consist of Members, Honorary Members and Associate Members.

MEMBERS.

SEC. 2.—Members must be at least twenty-one years of age and have had two years' actual experience in some branch of engineering or surveying, or shall have been graduated from an engineering course in a college or university of recognized standing, and they only shall be entitled to vote or transact business for the Society.

HONORARY MEMBERS.

SEC. 3.—Honorary Members may be as many as the Society shall elect. They shall have no vote, nor shall they be eligible to hold office. They shall have the right to attend all public meetings and to enjoy such other privileges as the Society may see fit to grant, excepting, however, such Honorary Members as may be elected from *active membership*, when they shall retain their right to vote and to hold office.

ASSOCIATE MEMBERS.

SEC. 4.—Any person desiring to become associated with this Society, who is not eligible to active membership, may make application, and if said application receives a favorable report from the Board of Direction, it shall be acted upon by the Society at the next regular meeting, and if said candidate shall receive a majority of the votes cast he shall be declared elected as an Associate Member. Associate Members shall have no vote, nor shall they be eligible for any office.

ARTICLE III.

OFFICERS AND THEIR DUTIES.

OFFICERS.

SECTION 1.—The officers of the Society shall be a President, two Vice Presidents, a Secretary and Treasurer, an Assistant Secretary, and four Directors, one of whom shall be the last living Ex-President.

ELECTION OF OFFICERS.

SEC. 2.—The officers, excepting the Assistant Secretary and the Director who is the last living Ex-President, shall be elected at the annual meeting, and shall hold their respective offices until the final adjournment of the meeting in which others are elected and qualified in their places.

PRESIDENT.

SEC. 3.—The President shall preside at all meetings when present. He shall be chairman of the Board of Direction, and of all standing committees, and shall appoint all special committees, unless otherwise ordered by a vote of the Society.

VICE PRESIDENTS.

SEC. 4.—In the absence or inability of the President to act, the Senior Vice President present shall perform his duties.

SECRETARY.

SEC. 5.—The Secretary shall attend all meetings of the Society, and the Board of Direction, and shall keep the minutes thereof. He shall conduct the general correspondence of the Society, receive communications addressed thereto, and present the same to the proper committees, officers, or meetings. He shall issue notices of all meetings, inform committees of their appointment, and officers and new members of their election. He shall notify all committees of coming meetings and prepare the matters for presentation. He shall keep a complete list of all members, with their addresses and dates of election. He shall publish the annual report. He shall perform such other duties pertaining to his office as may be imposed upon him by the Society or by the Board of Direction, and shall receive a salary to be fixed by the Society.

TREASURER.

SEC. 6.—The Treasurer shall keep the accounts, collect all the funds of the Society and shall deposit the same to the credit of the Society in such depository as may be designated by the Board of Direction. He shall pay all bills, when approved by the President or a majority of the Board of Direction. He shall keep book accounts of his receipts and expenditures, which shall at all times be open to the inspection of the Board. He shall make a duly audited itemized report to the annual meeting. He shall give bonds for the faithful performance of his duties, in such amounts and with such sureties as the Board of Direction may require, and he shall receive such remuneration as the Society may vote to him from time to time. The Board of Direction shall audit the Treasurer's accounts and books annually.

ASSISTANT SECRETARY.

SEC. 7.—The Assistant Secretary shall be appointed annually by the President, and his duties shall be such as would pertain to the office of executive secretary.

BOARD OF DIRECTION.

SEC. 8.—This Board shall consist of the President, the two Vice Presidents, and the four Directors. It shall have supervision and care of all the affairs of the Society and shall conduct the same in accordance with the Constitution and By-Laws. The President or one of the Vice Presidents shall preside at all meetings of the Board in the order of seniority. In the absence of all these officers a chairman *pro tem.* may be appointed for the meeting. At the annual meeting in February, 1916, only one Director shall be elected, to serve for one year. At the annual meeting in February, 1917, three directors shall be elected, one to serve for one year, one to serve for two years, and one to serve for three years; and at each subsequent annual meeting one director shall be elected to serve for three years. A Director elected at and after the annual meeting in 1917 shall not be eligible for reëlection to any office until one year after his term of office has expired. At the annual meeting in 1917, the person receiving the highest number of votes shall be the director for three years, the one receiving the next highest number of votes, the director for two years, and the one receiving the next highest number, the director for one year. In case of a tie vote, the terms of office shall be decided by lot. Four members shall constitute a quorum to transact business.

ARTICLE IV.

ELECTIONS.

OFFICERS, WHEN ELECTED.

SECTION 1.—At each annual meeting the Society shall elect by ballot a President, two Vice Presidents, a Secretary and a Treasurer, to serve one year. At the annual meeting in 1916, a Director shall be elected to serve one year; at the annual meeting in 1917 three Directors shall be elected, one to serve one year, one to serve two years and one to serve three years. At each annual meeting after 1917 one Director shall be elected to serve three years.

NOMINATIONS, HOW MADE.

SEC. 2.—A nominating blank, containing a list of officers to be voted for, shall be sent by the Secretary to each member, at least sixty (60) days before the day of the annual meeting. The nominations for officers shall be returned to the Secretary in an envelope endorsed with the member's signature, within twenty-one (21) days from the date upon which the blanks were mailed to members, and shall be delivered by him, unopened, to the Board of Direction at a meeting to be held by them to canvass such nominations.

A member nominated for an office by as many as ten (10) other members may become a candidate for that office. If a member be nominated for more than one office, he shall be considered as having been nominated for that office for which he received the most nominating ballots.

If no member receives ten (10) nominating ballots for an office, or if for any reason there should be no candidate for an office, the Board of Direction shall nominate at least two candidates for that office.

All nominees for office shall be notified at once by the Secretary of their nomination and, unless the Secretary receives a prompt declination, it shall be assumed that they have accepted such nomination.

ELECTIONS, HOW CONDUCTED.

SEC. 3.—At least twenty-one (21) days before the annual meeting the Secretary shall send each member a ballot, containing the names (arranged alphabetically) of the candidates for each office. This shall be accompanied by an envelope addressed to the Secretary, with a blank space on the back for the signature of the member voting, also a blank envelope carrying no mark for recognition.

Each member shall signify his choice of candidates on the ballot and return it to the Secretary in two sealed envelopes; the inner one to be left entirely blank, and the outer one endorsed with signature of sender.

Ballots may be sent by mail to the Secretary or handed to him directly. The Secretary shall deliver the ballots, unopened, to the tellers appointed by the presiding officer.

The polls will close at eleven o'clock in the morning of the day of the regular annual business meeting of the Society.

MEMBERS IN ARREARS CANNOT VOTE.

SEC. 4.—It shall be the duty of the Treasurer to furnish the tellers with an alphabetical list of members in arrears for dues for two years or more, and no vote from a member so in arrears shall be counted. Ballots received from such members shall be returned to them unopened with a statement of the reason for such action.

PLURALITY ELECTS.

SEC. 5.—The candidate for each office receiving a plurality of the votes shall be declared elected. In case of a tie vote, the meeting shall proceed to vote by ballot for the candidates who are tied.

NOTIFICATION.

SEC. 6.—The Secretary shall officially notify in writing each officer of his election.

Officers so elected shall qualify and assume their duties immediately after the adjournment of the meeting at which they are elected, and shall hold office until their successors are duly elected and qualified.

VACANCIES.

Sec. 7.—Vacancies occurring for any cause in the list of officers shall be filled by the Board of Direction.

ELECTION OF MEMBERS.

Sec. 8.—Each application shall be announced on the notices for the next meeting after it is received, shall then be considered by the Board of Direction, and, if approved, shall be presented to the Society for ballot at a regular meeting. If a candidate receives a majority of the ballots, he shall be declared elected. In case of rejection, no minute shall be published, but the Secretary shall notify the applicant by letter.

APPLICATION FOR MEMBERSHIP.

Sec. 9.—All applications for membership or for transfer from one grade of membership to another, shall be made on a regular form, to be secured from the Secretary, and to be endorsed by three Members. This form shall contain, immediately over the signature of the applicant, a clause in which the applicant shall agree that if elected he will be governed in all Society matters by the Constitution and By-Laws, and will forward the interests of the Society at all times.

ARTICLE V.

MEETINGS.

ANNUAL MEETINGS.

Section 1.—There shall be a *regular annual meeting* held on the third Tuesday of February of each year, at such place as may be selected by the Board of Direction, of which due notice shall be given by the Secretary.

MEETINGS, HOW CALLED.

Sec. 2.—Special meetings may be called by the President and, when so called, notice of the meeting specifying the business thereof shall be mailed by the Secretary to the postoffice address of each member at least ten days before such meeting shall be held. Special meetings shall be called by the President on written application of any ten (10) members.

QUORUM.

Sec. 3.—Ten per cent. of the membership shall constitute a quorum for the transaction of ordinary business, except for the election of officers or for voting on amendments to the Constitution or By-Laws, which shall require fifteen per cent.

ARTICLE VI.

DUES.

Section 1.—The annual dues of members and associate members shall be four ($4.00) dollars per year, payable in advance at the annual meeting.

Members elected at any time of the year shall pay full dues for that year.

Sec. 2.—Honorary Members shall pay no annual dues.

Sec. 3.—The Board of Direction shall have power to remit dues when, in their opinion, it is for the best interest of the Society.

ARTICLE VII.

DEPRIVATION OF MEMBERSHIP.

Section 1.—Any member whose dues shall remain unpaid for two (2) years shall be notified by the Treasurer, by sending by registered mail a bill for dues in arrears, on the face of which bill shall be printed the sections of the Constitution covering such cases. If the dues are not paid within thirty (30) days after such notification, the matter shall be presented to the Board of Direction, who shall have power to drop such member from the roll.

RESIGNATIONS.

Sec. 2.—Resignations must be submitted in writing to the Secretary, and may be accepted by the Board of Direction when all indebtedness to the Society has been discharged.

Sec. 3.—All charges against any member shall be investigated by the Board of Direction before being submitted to the Society.

Any member may be expelled for conduct which may be deemed prejudicial to the Society, by a two-thirds vote of the Members present at a business meeting; provided, that not less than fifteen (15) vote for expulsion, and that such member shall have had one month's notice of the charges preferred against him and of the time appointed for their consideration. All charges must fully set forth the offense or offenses alleged, and must be signed by the members preferring them. An attested copy must be furnished the accused, who shall be entitled to be present and to be heard in defense, in person or by attorney, at all meetings at which the charges are investigated, except during the time when a final vote is being taken.

ARTICLE VIII.

AMENDMENTS TO CONSTITUTION.

Section 1.—Proposed amendments to this Constitution must be presented in writing at a regular business meeting of the Society, and signed by at least three members. Amendments so presented shall be read at the meeting and a copy filed with the Secretary at the same time. At the meeting when presented the proposed amendments may be discussed and amended, and if approved by the meeting shall be submitted to a letter ballot by the Society at the next regular business meeting.

Sec. 2.—At any regular business meeting the amendments previously proposed, according to Section 1, may be voted upon by letter ballot. These ballots shall be sent out with the call for the meeting and shall have the proposed amendment, together with the section of the present Constitution covering the point in question, printed upon the ballot. With the ballot shall also be sent an envelope directed to the Secretary and marked "Ballot on Amendment." The Secretary shall keep these letters unopened and present to the presiding officer all replies received up to the hour of closing the polls. Tellers shall be appointed by the presiding officer, who shall open and count all ballots. The result shall be announced at the meeting by the presiding officer. Two-thirds of the ballots cast will be necessary for the adoption of an amendment.

Sec. 3.—The Board of Direction is authorized to number the Articles and Sections of the Constitution and By-Laws to correspond with any changes that may be made.

BY-LAWS.

MEETINGS.

1. In addition to the regular annual meeting, as provided by the Constitution, the Society shall hold at least one other general meeting, and may hold such other meetings to listen to lectures or addresses, or to visit engineering works of interest, or of a purely social nature, as the Board of Direction may decide to call.

GENERAL ORDER OF BUSINESS AT ANNUAL MEETING.

2. The following general order of business shall be observed at annual meetings:

    1. Presentation of, and action upon, minutes of last meeting.
    2. Report of Board of Direction.
    3. Report of Secretary.
    4. Report of Treasurer.
    5. Report of any Special Committees.
    6. Election of new members.
    7. Election of officers.
    8. Address of President.
    9. Miscellaneous business.
    10. Papers, lectures or addresses.
    11. Adjournment.

BUSINESS MEETING—ORDER.

3. The following general order shall be observed at Business Meetings:

    1. Presentation of, and action upon, minutes of last meeting.
    2. Miscellaneous announcements.
    3. Stated business.
    4. Adjournment.

4. Contributing Members under the old Constitution shall become Associate Members upon the adoption of the Revised Constitution.

5. Actual personal transportation expenses incurred by the Secretary in attending meetings shall be paid from the Society treasury, upon approval of the President or two members of the Board of Direction.

6. In the election of Honorary Members, a unanimous vote is necessary to elect.

7. The Society may at any time, duly named for the purpose, enact By-Laws for the future guidance, consonant with the Constitution. These By-Laws may be amended or repealed at any meeting, in the call for which meeting a copy of the proposed amendment or addition shall have been printed and sent to each member with the said notice.

PARLIAMENTARY RULES.

8. In all questions arising at any meeting, involving parliamentary rules, not provided for in these By-Laws, Roberts' Rules of Order shall be the governing authority.

VISITORS.

9. Visitors may be admitted to meetings under such rules as the meeting may prescribe.

10. All forms, such as blanks for application for membership, ballots for officers, ballots on amendments to Constitution or By-Laws, and other necessary blanks for the conduct of the business of the Society, shall be prepared by the Secretary and approved by the Board of Direction.

CHARTER MEMBERS OF THE SOCIETY.

HONORARY

Prof. John E. Clark	April, 1884
George H. Frost*	April, 1884

ACTIVE

E. P. Augur	April, 1884
C. H. Bunce	April, 1884
L. W. Burt	Jan. 13, 1885
C. E. Chandler	April, 1884
R. S. Hulbert	April, 1884
C. M. Jarvis	April, 1884
H. J. Kellogg	April, 1884
F. W. Laforge	Jan. 13, 1885
W. B. Palmer	Jan. 13, 1885
S. C. Pierson*	Jan. 13, 1885
A. W. Rice	April, 1884
William G. Smith	April, 1884
Nelson J. Welton*	April, 1884

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* Deceased.

Alphabetical List of Members.

With Addresses and Dates of Election.

Members are particularly requested to inform the Secretary at once of any change in address.

HONORARY MEMBERS.

BRECKENRIDGE, Lester P. (Feb. 9, 1914), Director Mason Laboratory, Yale University, New Haven, Conn.

CHITTENDEN, Prof. Russell H. (April 20, 1901), Dean of Sheffield Scientific School of Yale University, New Haven, Conn.

CLARK, John E. (April, 1884), Professor Mathematics, Emeritus, at Sheffield Scientific School, Yale University, Springfield, Mass.

FITZGERALD, Desmond (Jan. 8, 1901), Consulting Engineer, Brookline, Mass.

FULLER, William B. (Feb. 12, 1908), Consulting Engineer, 150 Nassau St., New York.

HADLEY, Dr. Arthur T. (April 20, 1901), President Yale University, New Haven, Conn.

HAUPT, Lewis M. (Feb. 12, 1907), Consulting Engineer, Cynwyd, Pa.

HAYNES, Edward C. (Jan. 14, 1890), 415 Ash St., Erie, Pa.

LUTHER, Flavel S., Jr. (Feb. 9, 1904), President Trinity College, Hartford, Conn.

PETTEE, William E. (Jan. 10, 1899), Civil Engineer, Salisbury, Conn.

SKINNER, Frank W. (Jan. 9, 1900), Editorial Staff of the Engineering Record, New York.

MEMBERS.

ALDERSON, Algernon B. (Jan. 10, 1899), Civil Engineer, West Hartford, Conn.

ALLEN, George B. (Aug. 12, 1908), Mill Architect and Civil Engineer, 169 Maple St., Springfield, Mass.

AMRHYN, Gustave X. (Associate Member, Feb. 9, 1904), Superintendent of Parks, New Haven, Conn.

ANDREWS, Ralph J. (Feb. 11, 1913), Civil Engineer, 352 Willow St., Waterbury, Conn.

ARNOLD, Walter T. (Aug. 8, 1917), Civil Engineer, H. Wales-Lines Co., Meriden, and *for mail,* 105 Elm St., Meriden, Conn.

ATWOOD, Thomas C. (Feb. 15, 1916), Consulting Engineer, 185 Church St., New Haven, Conn.

AUGUR, Edwin P. (April, 1884), 59 Broad St., Middletown, Conn.

AYMEN, Nathan (Feb. 14, 1912), Assistant Engineer, 18 City Hall, New Haven, and *for mail,* 635 Congress Ave., New Haven, Conn.

AZHDERIAN, Reuben B. (Feb. 12, 1907), Assistant Engineer for Passaic Valley Sewerage Commissioners, Newark, and *for mail,* 57 Nelson Place, Newark, N. J.

BACKES, William J. (Feb. 8, 1910), Engineer, Maintenance of Way, N. Y., N. H. & H. R. R., New Haven, Conn.

BACON, Arthur W. (Feb. 9, 1904), Hall & Bacon, Civil Engineers, New Britain, Conn.

BALDWIN, George T. (Feb. 15, 1916), Civil Engineer, New Haven, Conn.

BANTA, D. Schuyler (Aug. 23, 1905), Civil Engineer, N. Y., N. H. & H. R. R., New Haven, and *for mail,* 217 Alden Ave., New Haven, Conn.

BARKER, George P. (Aug. 13, 1913), Construction Engineer, H. Wales Lines Co., Meriden, and *for mail,* 163 Elm St., Meriden, Conn.

BARKER, William H. (Aug. 10, 1904), Expert in Patent Causes, 160 Broadway, New York.

BARNES, Niar (Feb. 10, 1914), 100 West Prospect St., New Haven, Conn.

†BARNEY, Samuel E. (Jan. 9, 1900), Assistant Professor Civil Engineering, Sheffield Scientific School, Yale University, New Haven, Conn.

BARTLETT, Frank R. (Aug. 17, 1909), Estimator, 26 Church St., Meriden, and *for mail,* 21 Lambert Ave., Meriden, Conn.

BEACH, C. Edward (Jan. 10, 1893), Civil Engineer, West Hartford, and *for mail,* Beach & Co., Hartford, Conn.

BEARD, Theodore W. (Feb. 10, 1914), Construction Engineer, Chase Metal Works, Department 900, Waterville, and *for mail,* 71 Wooster St., Shelton, Conn.

BEELER, Cresson L. (Feb. 19, 1918), Civil Engineer, N. Y., N. H. & H. R. R. Co., New Haven, Conn.

BEIN, Howard K. (Feb. 20, 1917), New Haven, Conn.

BENNETT, Charles J. (Aug. 14, 1906), State Highway Commissioner, State Capitol, Hartford, Conn.

BERNHARD, William E. (Feb. 15, 1916), Civil Engineer, Bridgeport, Conn.

BILDERBECK, George L. (Feb. 9, 1915), Civil Engineer, Groton, Conn.

BISHOP, Carlton T. (Aug. 13, 1913), Assistant Professor Structural Engineering, Sheffield Scientific School, Yale University, New Haven, and *for mail,* 284 Alden Ave., New Haven, Conn.

BLAIR, Clarence M. (Aug. 10, 1904), Civil Engineer, A. B. Hill, 100 Crown St., New Haven, and *for mail,* 785 Edgewood Ave., New Haven, Conn.

BLAKESLEE, Albert D. (Associate, Aug. 8, 1916, Active, Feb. 19, 1918), Superintendent, C. W. Blakeslee & Sons, 58 Waverly St., New Haven, and *for mail,* 100 Dwight St., New Haven, Conn.

BLAKESLEE, Clarence (Jan. 9, 1900), Civil Engineer and Contractor, New Haven, Conn.

BLAKESLEE, Harold L. (Feb. 11, 1913), Superintendent, C. W. Blakeslee & Sons, 58 Waverly St., New Haven, and *for mail,* 596 George St., New Haven, Conn.

BLAKESLEE, Miles Grant (Feb. 19, 1918), Civil Engineer, C. W. Blakeslee & Sons, New Haven, Conn.

BLATCHLEY, William J. (Aug. 10, 1904), Treasurer, New Haven Engineering & Construction Co., 82 Church St., New Haven, Conn.

BOLTON, William M. (Aug. 12, 1915), Civil Engineer, 18 City Hall, New Haven, and *for mail,* 35 Ellsworth Ave., New Haven, Conn.

BOWEN, J. Frank (Feb. 14, 1911), Superintendent Roads and Bridges and Town Engineer, Manchester, Conn.

BOYLAN, James E. (Feb. 14, 1912), Engineering Department, Berlin Construction Co., Berlin, and *for mail,* Middletown, Conn.

BRADLEY, Daniel E. (Jan. 9, 1894), Berlin Construction Co., Berlin, and *for mail,* 1021 Asylum Ave., Hartford, Conn.

BRADLEY, Edward F. (Feb. 9, 1915), Assistant Engineer, N. Y., N. H. & H. R. R., Willis Ave. and 132d St., New York City, and *for mail,* New Rochelle, N. Y.

BREWER, Willard S. (Feb. 12, 1907), Division Engineer, City Engineer's Office, Hartford, and *for mail,* 25 Salem St., Hartford, Conn.

BRINK, Herbert E. (Feb. 19, 1918), Civil Engineer, New Haven, Conn.

BRINSMADE, Daniel E. (April 20, 1901), Secretary and Assistant Engineer Ousatonic Water Co., Shelton, Conn.

BROWN, Charles B. (Aug. 14, 1907), Professor of Railroad Engineering, University of Maine, Orono, Maine.

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†In Government service.

BROWN, Charles O. (Jan. 11, 1898), City Engineer, Danbury, Conn.

†BROWN, Raymond J. (Feb. 15, 1916), General Draftsman, Chief Engineer's Office, N. Y., N. H. & H. R. R., New Haven, and *for mail,* 1231 Central Ave., Bridgeport, Conn.

BUCK, Henry Robinson (Jan. 10, 1899), Prest. Ford, Buck & Sheldon, Consulting Engineers, 60 Prospect St., Hartford, Conn.

BUNCE, C. H. (April, 1884), Civil Engineer, P. O. Box 307, Hartford, Conn.

BURGESS, Harold T. (Feb. 15, 1916), Civil Engineer, C. W. Blakeslee & Sons, 58 Waverly St., New Haven, and *for mail,* 24 Winthrop Terrace, Meriden, Conn.

BURGHARDT, Wallace W. (Feb. 13, 1906), Engineer, Canaan, Litchfield County, Conn.

†BURNS, William H. (Feb. 15, 1916), Civil Engineer, Farnumsville, Mass. .

BURROS, Aaron (Feb. 19, 1918), Civil Engineer, Scoville Mfg. Co., Waterbury, Conn.

BURT, Luther Harold (Aug. 14, 1900), Member L. W. Burt & Son, Civil and Consulting Engineers, 721 Main St., Hartford, Conn.

BURT, Luther W. (Jan. 13, 1885), Civil and Consulting Engineer, L. W. Burt & Son, 721 Main St., Hartford, and *for mail,* 62 Imlay Sq., Hartford, Conn.

BUSCHOR, Emil C. (Jan. 10, 1899), Assistant Engineer, Rapid Transit Subway Construction Co., 165 Broadway, New York, and *for mail,* 324 Second Ave., Roselle, N. J.

BUSH, Edward W. (Jan. 10, 1899), Member State Board of Engineers having supervision over Dams and Reservoirs, 863 Asylum Ave., Hartford, Conn.

BUSHELL, Arthur W. (Feb. 20, 1917), 309 Thayer Building, Norwich, Conn.

BUSHNELL, W. G. (Associate Member, Feb. 14, 1905), Electrical Engineer, New Haven, Conn.

CADWELL, William H. (May 31, 1893), Civil Engineer, New Britain, Conn.

CAHN, Alexander (Jan. 9, 1900), Civil Engineer, New Haven, Conn.

CAIRNS, Robert A. (Aug. 29, 1890), Sanitary and Hydraulic Engineer and City Engineer, Waterbury, Conn.

CAMPBELL, Carrol A. (Feb. 9, 1909), Director of Public Works, Middletown, Conn.

CARLISLE, H. E. (Jan. 9, 1900), Conduit Engineer, Southern New England Telephone Co., New Haven, and *for mail,* 150 Hallock Ave., New Haven, Conn.

CARMALT, L. J. (Feb. 19, 1918), Engineering Department N. Y., N. H. & H. R. R., New Haven, Conn.

CARROLL, Charles D. (Feb. 14, 1911), Civil Engineer, Rivers, Harbors and Bridges Commission, New London, and *for mail,* 914 Bank St., New London, Conn.

CHAFFEE, Robert N. R. (Aug. 15, 1916), Civil Engineer, 35 South Miller St., Newburgh, N. Y., and *for mail,* 572 Broad St., Meriden, Conn.

CHAMBERLIN, Cyrus C. (Associate Member, Feb. 15, 1916), Civil Engineer, Plantsville, Conn.

CHANDLER, Charles E. (April, 1884), Chandler & Palmer, City Engineers, 161 Main St., Norwich, Conn.

CHAPMAN, Charles H. (Associate Member, Feb. 15, 1916), Manager Bridgeport Division, Connecticut Company, Bridgeport, and *for mail,* 924 Broad St., Stratford, Conn.

CHASE, Charles F. (March 30, 1900), Chief Engineer, Berlin Construction Company, Berlin, and *for mail,* 241 West Main St., New Britain, Conn.

CLARK, Herbert G. (July 18, 1899), Assistant Engineer, Department of Engineering, Hartford, and *for mail,* 4 West Clay St., Hartford, Conn.

CLARK, Roscoe N. (July 18, 1899), City Engineer, Hartford, Conn.

CLARK, William S. (July 14, 1890), Civil Engineer, Meriden, Conn.

CLARKE, Stanley N. (Aug. 16, 1911), Civil Engineer, Milford, Conn.

CLARKE, Vincent B. (Feb. 9, 1904), City Engineer, Ansonia, and *for mail,* 29 Jackson St., Ansonia, Conn.

CLARKE, Waldo E. (Feb. 10, 1914), Resident Engineer, Rivers, Harbors, and Bridges Commission, New London, and *for mail,* 883 Montauk Ave., New London, Conn.

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†In Government service.

CLOSE, F. Perry (Feb. 19, 1918), Division Engineer, Municipal Building, Hartford, Conn.

†CODAIRE, Alfred H. (Feb. 15, 1916), Assistant Engineer, Bureau of Engineering, New Haven, Conn.

COE, Frederick L., Consulting Civil Engineer, Lynch & Coe: Associated with Charles A. Ferry, 82 Church St., New Haven, Conn.

COE, Theodore I. (Jan. 9, 1900), Architect, Room 1100, Municipal Building, New York, N. Y.

COGGESHALL, R. C. P. (June, 1887), Superintendent, Water Department, New Bedford, and *for mail*, 87 Court St., New Bedford, Mass.

COLGAN, Alfred P. (Feb. 9, 1915), Civil Engineer, 44 Beacon St., Waterbury, Conn.

COLGAN, William R. (Feb. 9, 1915), Civil Engineer, Waterbury, Conn.

†COLLINS, Edward T. (Feb. 11, 1913), U. S. Geological Survey, New London, Conn.

COLLINS, Harry C. (July 18, 1899), Contracting Engineer, Berlin Construction Co., Springfield, Mass.

COMSTOCK, Lewis B. (Aug. 10, 1904), Civil Engineer, Comstock Block, East Hartford, Conn.

†CONE, Joseph W. (Aug. 12, 1908), Civil Engineer, Greenwich, Conn.

†CONNOR, M. A. (Feb. 14, 1911), Civil Engineer, 347 Wethersfield Ave., Hartford, Conn.

CRAM, Roy C. (Feb. 8, 1910), Assistant Engineer, Way and Structure, Brooklyn Rapid Transit Co., Brooklyn, and *for mail*, 412 Ocean Ave., Brooklyn, N. Y.

CRANDALL, George K. (Jan. 11, 1887), City Surveyor, 98 State St., New London, Conn.

CRAWLEY, E. W. (Feb. 14, 1912), U. S. Junior Engineer, U. S. Engineer's Office, New London, and *for mail*, 60 Vauxhall St., New London, Conn.

†CROSS, Robert Ellis (Feb. 15, 1916), Department of Engineering, Municipal Building, Hartford, and *for mail*, 315 Pearl St., Hartford, Conn.

CURTIS, Abner L. (Feb. 14, 1912), Assistant Engineer of Construction, N. Y., N. H. & H. R. R. Co., Pawtucket, and *for mail*, 1 Prince St., Pawtucket, R. I.

CURTIS, Charles D. (Aug. 17, 1909), Civil Engineer, 98 Church St., Naugatuck, Conn.

CURTIS, Fayette S. (Jan. 9, 1900), Vice President, N. Y., N. H. & H. R. R., Boston, Mass.

CURTIS, George H. (Aug. 17, 1909), Freight Office, Willets Avenue, New York City.

DABOLL, Ernest C. (Feb. 14, 1911), Civil Engineer, Groton, Conn.

DABOLL, Loren E. (Jan. 8, 1895), Civil Engineer, New London, Conn.

DARROW, Courtland R. (Jan. 8, 1895), Civil Engineer, Waterford, Conn.

DAVIS, Arthur L. (July 18, 1899), Division Manager, American Bridge Co., 30 Church St., New York, N. Y.

DAVIS, Frank J. (Feb. 14, 1911), Superintendent, Ansonia Water Co., Ansonia, and *for mail*, 51 Franklin St., Ansonia, Conn.

DAVIS, Walter M. (Associate Member, Aug. 13, 1913), New Haven, Conn.

DEMING, Charles R. (Feb. 20, 1917), with Ford, Buck & Sheldon, Inc., Hartford, and *for mail*, 701 Franklyn Ave., Hartford, Conn.

DOANE, Royal B. (Feb. 20, 1917), Maple Hill, New Britain, Conn.

DePEYSTER, Frederick (Sept. 3, 1891), General Manager, The Brainerd, Shaler & Hall Quarry Co., Portland, Conn.

DEYO, Solomon LeF. (Jan. 9, 1900), Chief Engineer, New York Rapid Transit Subway Construction Co., New York City, and *for mail*, 2100 5th Ave., New York City.

DOERR, John H. (Feb. 11, 1913), Civil Engineer, Wescott & Mapes, New Haven, Conn.

DONAGHUE, Edward L. (Feb. 19, 1918), Civil Engineer, Department of Engineering, Hartford, Conn.

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†In Government service.

DONNELLY, Albert L. (Feb. 14, 1912), Assistant Engineer, Connecticut Company, New Haven, and *for mail,* 10 Lincoln St., New Haven, Conn.

DUNHAM, W. R., Jr. (Feb. 12, 1907), Engineer, Maintenance of Way, The Connecticut Co., New Haven, Conn.

DUNN, Herbert L. (Aug. 14, 1914), Civil Engineer, Woods Hole, Mass.

EASTERBROOK, Frederick J. (March 30, 1900), Resident Engineer, American Brass Co., Waterbury, Conn.

†ECKLE, John N. (Feb. 9, 1915), Civil Engineer, West Haven, Conn.

EDDY, Charles W. (Jan. 9, 1900), Assistant Engineer, Waterbury Water Supply, Thomaston, Conn.

ELLSWORTH, F. H. (March 30, 1900), Division Engineer, N. Y., N. H. & H. R. R. Co., New Haven, and *for mail,* 439 George St., New Haven, Conn.

ELTON, Herbert C. (Feb. 9, 1915), Civil Engineer, N. Y., N. H. & H. R. R. Co., General Offices, New Haven, and *for mail,* 202 Maple St., New Haven, Conn.

ELWELL, Charles Clement (Feb. 8, 1910), Public Utilities Commissioner, New Haven, and *for mail,* 71 College St., New Haven, Conn.

EVANS, Lafayette (Feb. 14, 1911), Second Assistant City Engineer, Bridgeport, Conn.

EVERIT, Edward H. (Oct. 11, 1902), Chief Engineer, Southern New England Telephone Co., New Haven, Conn.

FARNHAM, Charles S. (Feb. 9, 1904), Assistant Professor Civil Engineering, Sheffield Scientific School, New Haven, and *for mail,* 211 Norton St., New Haven, Conn.

FENELON, Earl Stanley (Feb. 15, 1916), Civil Engineer and General Foreman, Foundation Co., New York, N. Y., and *for mail,* Box 736, Bangor, Maine.

FERRY, Charles A. (Jan. 9, 1900), Consulting Engineer, 82 Church St., New Haven, Conn.

FOOTE, Clyde E. (Feb. 19, 1918), Civil Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

FORD, Frederick L. (Jan. 12, 1897), City Engineer, New Haven, Conn.

FORD, Theodore B. (April 20, 1901), Civil Engineer, 952 Main St., Bridgeport, Conn.

FRANCIS, George S. (Feb. 19, 1918), Civil Engineer, Department of Engineering, and *for mail,* Wethersfield, Conn.

FRECH, John L. (Feb. 20, 1917), Civil Engineer, N. Y., N. H. & H. R. R., and *for mail,* 17 Smith St., West Haven, Conn.

GAGEL, Edward (Jan. 9, 1900), Chief Engineer, N. Y., N. H. & H. R. R. Co., New Haven, Conn.

GAILOR, Chester F. (Feb. 15, 1916), Chief Engineer, Atlantic Welding Corporation, 30 Church St., New York City.

GAILOR, D. F. (Feb. 11, 1913), The Connecticut Co., New Haven, and *for mail,* 260 Orchard St., New Haven, Conn.

GEER, E. Selden, Jr. (Feb. 15, 1916), Safety Engineer, Travelers Insurance Co., Hartford, and *for mail,* 64 Niles St., Hartford, Conn.

GEER, Henry W. (Aug. 12, 1915), Civil Engineer, Middletown, Conn.

GLADDING, Henry H. (Jan. 9, 1900), Assistant City Engineer, New Haven, Conn.

GLYNN, John C. (Aug. 12, 1915), Civil Engineer, 420 Newport News Ave., Hampton, Va.

GOSS, Edward O. (Nov. 29, 1890), Assistant Treasurer, Scovill Manufacturing Co., Waterbury, Conn.

GRAVES, Edwin D. (Oct. 25, 1895), Civil Engineer, Hartford, Conn.

GREEN, Robert N. (Feb. 15, 1916), Town Engineer, Darien, Conn.

GREEN, Walter P. (Feb. 19, 1918), Civil Engineer, Scoville Manufacturing Co., Waterbury, and *for mail,* 15 Plank Road, Waterbury, Conn.

GREENWOOD, Albert H. (Feb. 9, 1904), Greenwood & Noerr, Consulting Engineers, 847 Main St., Hartford, Conn.

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†In Government service.

GREGORY, J. Louis (Aug. 10, 1901), General Contracting, 5 Lake Ave., Greenwich, Conn.

GOODELL, Paul G. (Feb. 19, 1918), Goodell & Palmer, 212 State St., Bridgeport, Conn.

HALL, A. Clark (Jan. 8, 1901), Civil Engineer, Bloomfield, Conn.

HALL, Charles Ernest (Feb. 12, 1907), Civil Engineer, Third Ave. Railroad Co., New York, N. Y.

HALL, George B. (Feb. 10, 1914), Civil Engineer, Waterbury, Conn.

HALL, Robert B. (Feb. 11, 1913), Civil Engineer, New Haven, Conn.

HALL, William H. (Feb. 12, 1907), City Engineer, New Britain, Conn.

HAM, George C. (Aug. 17, 1909), Civil Engineer, 98 Church St., Naugatuck, Conn.

HAMLIN, George E. (Aug. 12, 1915), State Highway Department, State Capitol, Hartford, and *for mail,* 24 May St., Hartford, Conn.

HANS, Alexander Joseph (Feb. 12, 1907), Chief Engineeer, Piping Rock Estates, Locust Valley, Long Island, N. Y.

HARRISON, Irving Warren (Feb. 12, 1907), City Engineer's Office, Waterbury, Conn.

HART, Jonathan T. (Feb. 15, 1916), Superintendent, Berlin Construction Co., Berlin, Conn.

HARTE, Charles Rufus (Aug. 10, 1904), Construction Engineer, The Connecticut Company, New Haven, Conn.

HASTINGS, F. B. (Associate Member, Feb. 10, 1903), B. D. Pierce Co., Bridgeport, Conn.

HAVEN, Ralph D. (Feb. 8, 1910), Civil Engineer, East Norwalk, Conn.

HAWLEY, Arthur S. (Feb. 11, 1902), C. W. Blakeslee & Sons, New Haven, Conn.

HEAD, Orrin W. (Feb. 15, 1916), Secretary, The R. D. Daley Co., 6 Church St., New Haven, Conn.

HENDERSON, John T. (July 18, 1899), Chief Engineer, Connecticut River Bridge and Highway District, 756 Main St., Hartford, Conn.

HEWLETT, William S. (Associate Member, Feb. 20, 1917), Bridgeport, Conn.

HICKEY, William F. (Feb. 9, 1909), Care of Carnegie Steel Co., Boston, Mass.

HILL, Albert B. (Jan. 9, 1900), Consulting Civil Engineer, 100 Crown St., New Haven, Conn.

HILLHOUSE, T. Curtis (Feb. 14, 1912), Civil Engineer, Bureau of Engineering, and *for mail,* 102 E. Pearl St., New Haven, Conn.

HINE, Frank E. (April 20, 1901), Superintendent, E. M. & W. Ferguson, Fishers Island, N. Y.

HOHENTHAL, Emil L. G., Jr. (Aug. 13, 1913), Building Contractor, 33 Ridgewood St., South Manchester, Conn.

HOLBROOK, Clarence G. (Feb. 13, 1912), City Engineer's Office, New Haven, Conn.

HOLLIS, Eben C. (Feb. 19, 1918), 36 Silver St., Waterbury, Conn.

HOSLEY, Robert M. (Aug. 23, 1905), Assistant Engineer, N. Y., N. H. & H. R. R. Co., New Haven, and *for mail,* 304 Ferry St., New Haven, Conn.

HOYT, Samuel W., Jr. (Feb. 9, 1904), Civil Engineer, 79 Washington St., South Norwalk, Conn.

HUBBARD, Charles E. (Associate Member, Aug. 17, 1909), 160-170 Front St., Hartford, Conn.

HULBERT, R. S. (April, 1884), Division Engineer, State Highway Department, Winsted, and *for mail,* 267 Rockwell St., Winsted, Conn.

HULL, William H. (Aug. 11, 1914), Civil Engineer, The T. A. Scott Co., Inc., New London, and *for mail,* 333 Ocean Ave., New London, Conn.

INESON, Frank (Feb. 19, 1918), Civil Engineer, Scovill Manufacturing Co., 310 Lincoln St., Waterbury, Conn.

JACKSON, J. Frederick (Jan. 9, 1900), Consulting Engineer, 185 Church St., New Haven, Conn., Director of Bureau of Sanitary Engineering, State Department of Health, Hartford, Conn.

JARVIS, Charles M. (April, 1884), Vice President, P. & F. Corbin Co., New Britain, Conn.

JAYNES, Frank B. (Feb. 10, 1903), Civil Engineer, 16 P. O. Arcade, Bridgeport, Conn.

JENSEN, James N. (Feb. 15, 1916), Civil Engineer, 279 Broad St., Bridgeport, Conn.

JOHNSON, Wm. D. (Aug. 14, 1900), President, Johnson & Burns, Inc., Architects, 26 State St., Hartford, Conn.

JOHNSON, William E. (Nov. 29, 1890), Division Engineer, Water Dept., Hartford, and *for mail,* West Hartford, Conn.

JOHNSTON, Merwin M. (Aug. 8, 1917), Civil Engineer, Connecticut Co., and *for mail,* 348 Sherman Ave., New Haven, Conn.

JONES, Walter A. (Feb. 10, 1903), Civil Engineer, Norfolk, Va.

JONES, Walter M. (Associate Member, Feb. 15, 1916), Civil Engineer, New London, Conn.

KEITH, Herbert C. (Jan. 9, 1900), Consulting Engineer, 154 Nassau St., New York, N. Y.

KELLEY, Raymond E. (Feb. 15, 1916), Civil Engineer, The J. H. Ellison Construction Co., Hartford, and *for mail,* 33 Stirling St., Hartford, Conn.

KELLOGG, Henry J. (April, 1884), Assistant City Engineer, New Haven, Conn.

KELLY, Cassius W. (Jan. 9, 1900), Consulting City Engineer, 18 City Hall, New Haven, Conn.

KENNEDY, Dennis A. (Associate Member, Aug. 13, 1913), 715 Tremont Temple, Boston, Mass.

KENT, Gilbert R. (Aug. 16, 1910), Civil Engineer, 71 Smith St., West Haven, Conn.

KILBY, Charles C. (Feb. 14, 1912), Superintendent A. C. Sternberg, Inc., West Hartford, Conn., and *for mail,* 148 Madison St., Hartford, Conn.

KIRBY, Richard Shelton (March 30, 1900), Assistant Professor of Drawing and Descriptive Geometry, Sheffield Scientific School, Yale University, New Haven, and *for mail,* 96 Linden St., New Haven, Conn.

KROMER, Frank (Aug. 16, 1910), Civil Engineer, 1147 Fulton St., New York City.

†LAFORGE, Frederick W. (Jan. 13, 1885), U. S. Engineer, Fort H. G. Wright, New London, Conn.

LAMBERT, Edward Allyn (Feb. 10, 1914), Chief Engineer, The Austin Company, Bridgeport, Conn.

LANE, E. LeRoy (Jan. 8, 1901), Contractor, Hingham, Mass.

LAW, Walter H. (Aug. 10, 1904), Civil Engineer, Tiverton, R. I.

LEIGHTON, Kenneth W. (Feb. 14, 1911), Assistant Engineer, A. B. Hill, New Haven, and *for mail,* 317 Edgewood Ave., New Haven, Conn.

LEOPOLD, Benjamin (Feb. 14, 1912), Civil Engineer, F. T. Ley Co., New York, and *for mail,* 531 W. 57th St., New York, N. Y.

LOCHRIDGE, Elbert E. (Aug. 23, 1905), Chief Engineer, Water Works, Springfield, and *for mail,* Box 1238, Springfield, Mass.

LONGDEN, Ruel H. (Feb. 15, 1916), Civil Engineer, 146 Cowles St., Bridgeport, Conn.

LUTZ, Frederick W. (Feb. 10, 1914), Civil Engineer, 96 Hobart St., New Haven, Conn.

LYNCH, Alexander S. (Aug. 14, 1907), 57 Holmes Street, West Haven, Conn.

MACKENZIE, Samuel H. (Feb. 9, 1915), Engineer and Superintendent, Water Department, Southington and Terryville Water Co., 102 Center St., Southington, Conn.

MACKENZIE, William A. (Aug. 11, [illegible]), Borough Engineer and Superintendent Water Department, Wallingford, Conn.

MACLEAN, George H. (Feb. 9, 1904), Treasurer, The Sperry Engineering Co., 82 Church St., New Haven, and *for mail,* 56 Brownell St., New Haven, Conn.

MAGILL, C. A. (Aug. 14, 1907), General Manager, Connecticut Hassam Paving Co., 902 Chapel St., New Haven, Conn.

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†In Government service.

MAGUIRE, John P. (Associate Member, Feb. 15, 1916), Civil Engineer, 50 Arch St., New Britain, Conn.

MANVILLE, E. Perry (Feb. 14, 1912), Resident Engineer, C. N. E. Ry., Hartford, and *for mail,* 860 Main St., East Hartford, Conn.

MARCHANT, Orson H. (Feb. 14, 1905), Civil Engineer, 100 Crown St., New Haven, and *for mail,* 241 Alden Ave., New Haven, Conn.

McCARTHY, Edward A. (Feb. 15, 1916), Civil Engineer, 158 Black Rock Ave., New Britain, Conn.

†McCLUSKEY, Charles A. (Aug. 13, 1913), Special Agent, Southern New England Telephone Co., Hartford, and *for mail,* 154 Hallock Ave., New Haven, Conn.

McDONALD, Charles E. (Feb. 14, 1912), 114 Benedict St., Waterbury, Conn.

McDONOUGH, Frank T. (Feb. 10, 1914), Field Engineer, Southern New England Telephone Co., New Haven, and *for mail,* 38 Hallock St., New Haven, Conn.

McDOWELL, Edwin T. (Aug. 8, 1917), Superintendent Water Department, Middletown, Conn.

McELROY, James A. (Feb. 9, 1909), City Engineer, and *for mail,* 307 Golden Hill, Bridgeport, Conn.

McKAIG, F. Paul (Aug. 11, 1914), Civil Engineer, The Connecticut Co., Hartford, and *for mail,* 182 Whitney St., Hartford, Conn.

McKENZIE, Thomas (Feb. 12, 1907), Engineer and Superintendent, Water Department, Westerly, R. I.

McKNIGHT, John T. (May 31, 1893), Retired from business, Rockville. Residence, Ellington, Conn.

McLAUGHLIN, Frank (Feb. 15, 1916), Civil Engineer, The Foundation Co., P. O. Box 204, Wheeling, W. Va.

MEEKER, Reginald C. (Feb. 9, 1915), Civil Engineer, So. New Eng. Tel. Co., New Haven, Conn.

MERRELS, Charles W. (Jan. 9, 1900), Assistant Engineer, City Engineer's Office, New Haven, Conn.

MERRITT, Malcolm (Aug. 12, 1908) Daly & Merritt, Contracting Engineers, Port Chester, N. Y.

MILLER, Irving C. (Feb. 19, 1918), Assistant Superintendent of Construction, Scovill Manufacturing Co., Waterbury, Conn.

MILLER, Rodney B. (Feb. 9, 1909), Civil Engineer, The B. H. Hibbard Co., New Britain, Conn.

MINOR, Edward E. (Feb. 9, 1904), Superintendent, New Haven Water Co., New Haven, Conn.

†MINOR, Pierpont L. (Feb. 11, 1913), Assistant Engineer, S. E. Minor, Greenwich, Conn.

MINOR, Sheldon E. (Sept. 25, 1886), Civil Engineer, 96 Greenwich Ave., Greenwich, Conn.

MITCHELL, R. E. (Jan. 9, 1900), City Engineer, 751 Main St., Willimantic, Conn.

MOONEY, James F. (Feb. 9, 1915), Civil Engineer, Thompsonville, Conn.

MOORE, William Harley (Jan. 9, 1900), Engineer of Structures, N. Y., N. H. & H. R. R., New Haven, Conn.

MOREHOUSE, Allison F. (Associate Member, Aug. 8, 1916), Superintendent of Buildings, 22 Church St., Meriden, and *for mail,* 14 Breckenridge Ave., Meriden, Conn.

MORTON, Walter S. (Aug. 10, 1904), Consulting Hydraulic Engineer, 2 Rector St., New York, N. Y.

MOSS, Ernest B. (April 20, 1901), Civil Engineer, H. Wales Lines Co., Meriden, Conn.

MURPHY, Harold T. (Feb. 9, 1904), Civil Engineer and Surveyor, 476 Main St., Springfield, Mass.

MURPHY, John P. (July 18, 1899), Assistant Engineer, Department of Engineering, Hartford, and *for mail,* 39 Wethersfield Ave., Hartford, Conn.

MYLCHREEST, George L. (Feb. 15, 1916), Designing Engineer, Ford, Buck & Sheldon, Hartford, and *for mail,* 238 Palm St., Hartford, Conn.

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†In Government service.

NASH, Paul (Jan. 9, 1900), City Engineer, Stamford, Conn.

NEWLANDS, James A. (Feb. 15, 1916), President, Henry Souther Engineering Co., 11 Laurel St., Hartford, Conn.

NEWMAN, Alden G. (Feb. 20, 1917), Member of Office Force A. B. Hill, 100 Crown St., New Haven, Conn.

†NICHOLS, Charles H. (Jan. 8, 1901), Consulting Engineer and Engineer of Shell Fish Commission, 185 Church St., New Haven, Conn.

NOERR, Robert Collyer, Greenwood & Noerr, Consulting Engineers, 847 Main St., Hartford, Conn.

O'CONNOR, Donn (Associate Member, Feb. 9, 1904), General Contractor, 720 Main St., Hartford, Conn.

OLMSTED, Horace B. (Feb. 20, 1917), Assistant Engineer, State Highway Department, 185 Church St., New Haven, Conn., and *for mail,* 515 South Main St., East Hartford, Conn.

OLMSTED, C. Henry (July 18, 1899), Civil Engineer, 1175 Main Street, East Hartford, Conn.

ORROK, Geo. A. (Feb. 9, 1909), Consulting Engineer, 17 Battery Place, New York, N. Y., and *for mail,* R. F. D. No. 2, Willimantic, Conn.

PALMER, Shepard B. (Jan. 8, 1895), Civil Engineer, 161 Main St., Norwich, Conn.

PALMER, William B. (Jan. 13, 1885), Palmer & Goodell, Civil Engineers and Surveyors, 211 State St., Bridgeport, Conn.

PARDEE, William S. (Associate Member, Aug. 10, 1904), 325 Lighthouse Road, New Haven, Conn.

PARKER, G. A. (July 18, 1899), Superintendent of Parks, Hartford, Conn.

PARSONS, Harold A. (Aug. 14, 1900), Civil and Consulting Engineer, Engineering Contractor, 49 Bank St., Stamford, Conn.

PATIENCE, Frederick G. (Feb. 9, 1909), Contracting Engineer, Berlin Construction Co., Berlin, and *for mail,* 25 Plainfield St., Hartford, Conn.

PATTERSON, Charles A. (Feb. 11, 1913), City Engineer, Torrington, Conn.

PATTON, Arthur J. (Sept. 12, 1889), Land Surveyor, 27 West Main St., Waterbury, Conn.

†PAYNE, Morris B. (Feb. 14, 1911), Payne & Adams, Architects and Engineers, State St., New London, Conn.

†PECK, Clifford A. (Aug. 12, 1915), Civil Engineer, New London, Conn.

PECK, Ermon M. (Jan. 8, 1895), Civil Engineer, 26 State St., Hartford, Conn.

PECK, Leon F. (Oct. 11, 1902), Superintendent of Streets, Hartford, Conn.

PENFIELD, George W. (Jan. 8, 1901), Assistant Engineer, Board of Water Commissioners, Hartford, and *for mail,* New Hartford, Conn.

PERRY, George W. (Aug. 11, 1914), Civil Engineer and City Engineer, City of Putnam, 15 Providence St., Putnam, Conn.

PHELPS, Howard E. (Aug. 8, 1917), Civil Engineer, New Haven, Conn.

PHELPS, James W. (Oct. 11, 1902), Landscape Architect, Bolton, Conn.

PHELPS, Jeffrey O., 4th (Aug. 12, 1915), Salesman, The Blodgett & Clapp Co., Hartford, and *for mail,* 38 Mansfield St., Hartford, Conn.

PIERCE, Bradford D., Jr. (Aug. 23, 1905), President, The Connecticut Quarries Co., New Haven, and *for mail,* Brooklawn Park, Bridgeport, Conn.

PITCHER, Floyd J. (Feb. 20, 1917), Consulting Engineer, 113 Church St., New Haven, and *for mail,* 95 Smith St., West Haven, Conn.

POLAND, Edward F. (Aug. 8, 1917), Superintendent, C. W. Murdock Co., New Haven, Conn.

POMEROY, Harlan D. (Aug. 8, 1916), Assistant Engineer, Town Engineer's Office, West Hartford, and *for mail,* 66 Imlay St., Hartford, Conn.

PORISS, Solomon C. (Aug. 13, 1913), Austin Co., Bulletin Building, Philadelphia, Pa.

†PORTER, Howard Samuel (Feb. 8, 1910), Chief Draftsman, Connecticut State Highway Commission, Capitol, Hartford, and *for mail,* 131 Collins St., Hartford, Conn.

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†In Government service.

PRANN, C. Perry (Aug. 8, 1916), Draughtsman, Electric Boat Co., Branford, and *for mail,* 44 Averill Place, Branford, Conn.

PRANN, Raymond (Aug. 8, 1917), Civil Engineer, Branford, Conn.

PRENTIS, Hugh L. (Feb. 10, 1914), Groton, Conn.

PRESTON, Charles H., Jr. (Feb. 12, 1907), Architect & Engineer, 136 Grand St., Waterbury, Conn.

PUNDERFORD, John K. (Jan. 9, 1900), Vice President and General Manager, The Connecticut Co., P. O. Box 1311, New Haven, Conn.

QUAY, John P. (Aug. 12, 1915), Structural Engineer, Berlin Construction Co., Berlin, and *for mail,* 10 Camp St., New Britain, Conn.

RANDLE, Jonathan S. (Feb. 14, 1911), Civil Engineer, 100 Crown St., New Haven, and *for mail,* 227 Sherman Ave., New Haven, Conn.

†RAPUANO, Joseph H. (Aug. 11, 1914), Civil Engineer, Connecticut Co., New Haven, and *for mail,* 132 Columbus Ave., New Haven, Conn.

†RASK, Peter K. (Feb. 15, 1916), Transitman, City Engineer's Office, Hartford, and *for mail,* 17 Crown St., Hartford, Conn.

REICHGOTT, David (Feb. 11, 1913), Civil Engineer, and *for mail,* 52 Dickerman St., New Haven, Conn.

RICE, Arthur W. (April, 1884), Retired, 29 Cedar St., New Britain, Conn.

RICH, Richard H. (Aug. 11, 1914), Assistant Engineer, Department of Real Estate, N. Y., N. H. & H. R. R., New Haven, and *for mail,* 414 Goffe St., New Haven, Conn.

RICHARDS, Howard S. (Aug. 11, 1914), Civil Engineer, Huntington St., New London, Conn.

ROBINSON, Leoni W. (Feb. 14, 1905), Architect, 42 Church St., New Haven, Conn.

ROBINSON, Ralph (Aug. 8, 1917), Civil Engineer, New Haven, Conn.

ROBINSON, Seymour N. (Feb. 9, 1904), Vice President and Treasurer, Berlin Construction Co., Berlin, and *for mail,* 145 Oxford St., Hartford, Conn.

ROGERS, Charles E. (Feb. 12, 1907), Professor, Civil Engineering, Trinity College, Hartford, Conn.

ROSS, Robert J. (Feb. 9, 1915), Assistant City Engineer, Municipal Building, Hartford, and *for mail,* 575 New Britain Ave., Hartford, Conn.

RYDER, E. M. T. (Jan. 9, 1900), Engineer, Maintenance of Way, Third Avenue Railway Co., New York, N. Y.

SAGE, George H. (Jan. 8, 1895), President, Berlin Construction Co., Berlin, and *for mail,* 1 Charter Oak Place, Hartford, Conn.

SAUNDERS, Richard L. (Feb. 9, 1909), Deputy State Highway Commissioner, State Capitol, Hartford, and *for mail,* 232 Sigourney St., Hartford, Conn.

SAVILLE, Caleb M. (Aug. 12, 1915), Chief Engineer, Board of Water Commissioners, 1026 Main St., Hartford, Conn.

SCHILLING, Albert H. (Aug. 14, 1906), Contracting Engineer, Berlin Construction Co., New Britain, and *for mail,* 29 Lincoln St., New Britain, Conn.

SCHREWE, Erwin W. (Aug. 12, 1915), Assistant Engineer, Scofield & Ford Co., 952 Main St., Bridgeport, Conn.

SCOTT, Thomas A. (Aug. 11, 1914), Contracting Engineer, New London, Conn.

SEARS, Selden P. (Feb. 14, 1912), Assistant Engineeer, Board of Water Commissioners, Hartford, and *for mail,* New Hartford, Conn.

SEGUR, Raymond H. (Feb. 20, 1917), Overseer, Street Dept., Municipal Building, Hartford, and *for mail,* 67 Farmington Ave., Hartford, Conn.

SELLERS, Philip (Feb. 9, 1904), Architect, 207 Orange St., New Haven, and *for mail,* 227 McKinley Ave., New Haven, Conn.

SHARP, W. H. (Aug. 11, 1914), Assistant Engineer, Connecticut State Highway Commission, 151 Main St., Middletown, and *for mail,* 55 Brainerd Ave., Middletown, Conn.

SHAUGHNESSY, James F. (Feb. 11, 1902), Assistant Engineer, Board of Water Commissioners, Hartford, and *for mail,* New Hartford, Conn.

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†In Government service.

SHELDON, Paul (Feb. 12, 1907), Ford, Buck & Sheldon, Inc., Consulting Engineers, Hartford, and *for mail*, P. O. Box 184, Hartford, Conn.

SHOOK, Berton (Feb. 15, 1916), Civil Engineer, City Hall, Bridgeport, and *for mail*, 211 Pacific St., Bridgeport, Conn.

SIBLEY, Charles A. (Feb. 11, 1908), Contracting Engineer, 902 Chapel St., New Haven, Conn.

SKILTON, Henry (Aug. 8, 1917), Civil Engineer, New Haven, Conn.

SMEAD, Ralph A. (Feb. 15, 1916), Structural Engineer, Ford, Buck & Sheldon, Inc., Hartford, and *for mail*, 118 Ann St., Hartford, Conn.

SMITH, Frink M. (Aug. 23, 1905), Engineer, C. W. Blakeslee & Sons, New Haven, and *for mail*, Pine Meadow, Conn.

SMITH, George E. (Feb. 10, 1903), Division Engineer, State Highway Department, Bank Building, New Milford, Conn.

SMITH, William G. (April, 1884), Superintendent of Water Works, Waterbury, and *for mail*, 17 First Ave., Waterbury, Conn.

SOEHRENS, J. H. (Aug. 10, 1904), Assistant Engineer, N. Y., N. H. & H. R. R., New London, and *for mail*, 121 Riverview Ave., New London, Conn.

SPENCER, Norman C. (Jan. 8, 1901), Spencer & Washburn, Civil Engineers, 573 Main St., Hartford, Conn.

SPENCER, Paul B. (Feb. 9, 1915), Civil Engineer, 209 Pequot Ave., New London, Conn.

SPENCER, Walter T. (Jan. 9, 1900), Superintendent, N. Y., N. H. & H. R. R., Taunton, *mail*, 25 Gibbs St., Brookline, Mass.

SPERRY, A. William (Jan. 9, 1900), Contracting Engineer, 82 Church St., New Haven, Conn.

SPRAGUE, John V. (Feb. 11, 1913), Engineering Contractor, 185 Church St., New Haven, Conn.

STARK, Melvin E. (Aug. 11, 1914), Superintendent of Tracks, The Connecticut Co., Bridgeport, *mail*, 3335 Main St., Stratford, Conn.

†STARKWEATHER, Walter H. (Feb. 11, 1913), Civil Engineer, Albert B. Hill, Consulting Civil Engineer, New Haven, *mail*, 69 Derby Ave., New Haven, Conn.

STEELMAN, Martin Somers (Feb. 15, 1916), Resident Engineer, Levering & Garrigues, Bristol, Conn., *mail*, P. O. Box 542, Waterbury, Conn.

STERLING, Paul (Oct. 11, 1902), Division Engineer, N. Y., N. H. & H. R. R., East 132d St., and Willis Ave., New York, N. Y., *mail*, 87 Grove St., Stamford, Conn.

STEVENS, Robert W. (Feb. 8, 1910), Division Engineer, State Highway Dept., Hartford County, *mail*, 408 Main St., Hartford, Conn.

STEWART, Alanson E. (Feb. 10, 1914), Civil Engineer, Torrington, Conn.

STODDARD, Raymond French (Jan. 9, 1900), Consulting Engineer, Bridgeport, Conn.

STONE, Edward M. (July 18, 1899), Private Business, 327 Trumbull St., Hartford, Conn.

STORRS, Henry W. (Aug. 23, 1905), Hartford Iron Works, Inc., P. O. Box 1028, Hartford, Conn.

STORY, I. Franklin (Aug. 21, 1912), Resident Engineer, Waterbury, and *for mail*, R. F. D. No. 1, Waterbury, Conn.

STORY, Isaac M. (Feb. 13, 1906), Civil Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

STOUT, Philip (Aug. 8, 1917), Civil Engineer, Burnside, Conn.

SULLIVAN, John M. (Aug. 10, 1904), Assistant Engineer Construction, N. Y., N. H. & H. R. R., New Haven, and *for mail*, 141 Bradley St., New Haven, Conn.

SUNDERLIN, George W. (Associate Member, Feb. 14, 1911), Toole & Sunderlin, Bridgeport, Conn.

TAYLOR, Charles F. (Aug. 12, 1908), Assistant Engineer, State Highway Department, Hartford, and *for mail*, 107 Blue Hills Ave., Hartford, Conn.

TAYLOR, George B. (Feb. 9, 1915), Designing Engineer, Berlin Construction Co., Berlin, and *for mail*, 96 Harrison St., New Britain, Conn.

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†In Government service.

TAYLOR, William T. (Feb. 9, 1904), Civil Engineer, 81 Sigourney St., Hartford, Conn.

TERRILL, Arthur P. (Feb. 20, 1917), 98 Broadway, New Haven, Conn.

TERRY, Alfred H. (Feb. 11, 1900), Civil Engineer, Bridgeport, Conn., *mail,* Penfield Road, Fairfield, Conn.

THAYER, Merwin A. (Feb. 14, 1912), Civil Engineer, 4 Fruit St., Winsted, Conn.

THAYER, Raymond E. (Feb. 14, 1912), Civil Engineer, New London, Conn.

THOMAS, James B. (Jan. 9, 1900), Civil Engineer, 34 Capen St., Hartford, Conn.

TIPPET, Henry J. (Aug. 8, 1917), Assistant Engineer, Connecticut Co., and *for mail,* 253 Central Ave., New Haven, Conn.

TODD, James W. (Associate Member, Aug. 16, 1910), 546 State St., New Haven, Conn.

TONER, James A. (Aug. 23, 1905), Assistant City Engineer, Meriden, and *for mail,* 99 Windsor Ave., Meriden, Conn.

TOOLE, John F. (Associate Member, Feb. 14, 1911), Toole & Sunderlin, Bridgeport, Conn.

TRACY, John C. (Jan. 9, 1900), Professor of Civil Engineering, Yale University, New Haven, and *for mail,* 345 Winthrop Ave., New Haven, Conn.

TRAVIS, Frank M. (Feb. 9, 1915), Civil Engineer, Torrington, Conn.

TROWBRIDGE, Frederick J. (Feb. 14, 1912), Field Engineer and Inspector of Construction, Hugh L. Thompson, Engineer of Scovill Manufacturing Co., Waterbury, and *for mail,* 35 Coniston Ave., Waterbury, Conn.

TRUESDELL, Walter E. (June 11, 1898), Secretary and Vice President, J. H. Wallace & Co., Industrial Engineers, 5 Beekman St., New York City.

†TRUMBULL, John F. (Aug. 10, 1904), Major, Engineers, Officers' Reserve Corps, 25th Engineers, N. A., Camp Devens, Ayer, Mass.

†TUCKER, John J. (Feb. 9, 1915), Construction Engineer, J. W. Bishop Co., Providence, R. I., and *for mail,* 1012 Whalley Ave., New Haven, Conn.

TURNER, Albert M. (Aug. 10, 1905), Field Secretary, Connecticut State Park Commission, Northfield, Conn.

TURNER, Homer R. (Feb. 20, 1917), Superintendent and Engineer, Windsor Water Board, Windsor, Conn.

ULRICH, W. Leroy (Aug. 14, 1913), Superintendent of Repairs, State Highway Department, Hartford, and *for mail,* 101 Ridgefield Street, Hartford, Conn.

UNKELBACH, Max J. (Jan. 9, 1900), Civil Engineer and Architect, Unkelbach & Perry, 162 Main St., New Britain, Conn.

UPSON, Warren D. (Feb. 20, 1917), West & Upson, General Building Contractors, 36 Pearl St., Hartford, Conn.

VAUGHN, Edward J. (Feb. 15, 1916), Civil Engineer, with Ford, Buck & Sheldon, Inc., 60 Prospect St., Hartford, and *for mail,* 26 Adelaide St., Hartford, Conn.

†VERRILL, G. E. (Feb. 11, 1902), Major, Engineers, U. S. R., Yellowstone Park, Wyo.

WADHAMS, Joseph Palmer (Feb. 9, 1904), Street Commissioner and City Engineer, Norwalk, Conn.

WADHAMS, M. Allyn (Feb. 19, 1918), Civil Engineer, Ford, Buck & Sheldon, Hartford, Conn.

WADSWORTH, A. R. (Oct. 27, 1886), Civil Engineer and Surveyor, Farmington, Conn.

†WALLER, William E. (Feb. 9, 1915), Box 99, Chestnut Hill, R. F. D. No. 1, Bridgeport, Conn.

WARDWELL, Frederick S. (Feb. 9, 1904), Contracting Engineer, Stamford, Conn.

WATERMAN, Charles P. (Feb. 11, 1908), Civil Engineer, The J. H. Grozier Co., 221 Main St., Hartford, Conn.

WATERMAN, Irville D. (Feb. 19, 1918), Construction Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

WATROUS, Kenneth (Feb. 14, 1911), Civil Engineer, Groton, Conn.

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†In Government service.

WATSON, Edmund B. (Aug. 11, 1914), Civil Engineer, 98 Park Ave., Danbury, Conn.

WATTERS, George E. (Feb. 14, 1911), Civil Engineer, 29 Darrow St., New London, Conn.

WELLS, Alden (Feb. 15, 1916), Assistant Engineer, Department of Engineering, Hartford, and *for mail,* 40 Freeman St., Hartford, Conn.

WHEELER, Charles A. (Jan. 8, 1901), Professor of Mathematics and Engineering for the Connecticut Agricultural College, Storrs, Conn.

WHITAKER, Raymond B. (Associate Member, Feb. 15, 1916), Line Measurer, 195 Broadway, Room 909, New York, and *for mail,* 395 Howard Ave., New Haven, Conn.

WHITE, Howard E. (Feb. 9, 1904), Assistant Superintendent, New Haven Gas Light Co., New Haven, and *for mail,* 175 Maple St., New Haven, Conn.

WHITNEY, Eli (March 30, 1900), 800 Whitney Ave., New Haven, Conn.

WHITON, Frank W. (Associate Member, Feb. 14, 1905), Whiton & McMahon, Architects, 36 Pearl St., Hartford, Conn.

WHITTMORE, J. B. (Feb. 9, 1915), Roadmaster, Shore Line Electric Railway Co., Norwich, and *for mail,* New London Turnpike, New London, Conn.

WIGGIN, Ernest W. (March 30, 1900), Consulting Engineer, 113 Church St., New Haven, Conn.

WIGHTMAN, Herbert B. (Aug. 16, 1910), Civil Engineer, 36 Lafayette St., Norwich, Conn.

WILLIAMS, Harry T. (Aug. 12, 1915), Civil Engineer, Waterbury, Conn.

WILLIAMS, Joseph D. (Feb. 15, 1916), Assistant Engineer, Department of City Engineering, New Britain, and *for mail,* 54 Garden St., New Britain, Conn.

WILLIAMS, Philip K. (Aug. 14, 1906), Secretary, J. B. Williams Co., Glastonbury, Conn.

WILSON, P. Ney (Aug. 14, 1913), Road Master, Connecticut Co., New Haven, and *for mail,* 263 Norton St., New Haven, Conn.

†WINSLOW, C.-E. A. (Aug. 8, 1916), Professor of Public Health, Yale Medical School, New Haven, and *for mail,* 202 Prospect St., New Haven, Conn.

WOLCOTT, Henry A. (July 18, 1899), Mechanical and Civil Engineer, West Hartford, Conn.

WOODS, John J. (Feb. 10, 1914), Civil Engineer, Baltic, Conn.

WORTHEN, Albert Louis (Feb. 15, 1916), Civil Engineer, 22 Pendleton St., New Haven, Conn.

WRIGHT, F. Walden (Aug. 12, 1908), Civil Engineer, Winchester Repeating Arms Co., New Haven, and *for mail,* 33 Edgewood Ave., New Haven, Conn.

YOUNG, Guilford D. (Feb. 20, 1917), 263 Elm St., New Haven, Conn.

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†In Government service.

Geographical List of Members

Names are usually arranged under their place of business

CONNECTICUT

Fairfield County

Bridgeport—W. E. Bernhard, R. J. Brown, C. H. Chapman (Assoc. M.), L. Evans, T. B. Ford, P. G. Goodell, F. B. Hastings (Assoc. M.), W. S. Hewlett (Assoc. M.), F. B. Jaynes, J. N. Jensen, E. A. Lambert, R. H. Longden, J. A. McElroy, W. B. Palmer, B. D. Pierce, Jr., E. W. Schrewe, B. Shook, M. E. Stark, R. F. Stoddard, G. W. Sunderlin (Assoc. M.), A. H. Terry, J. F. Toole (Assoc. M.), W. E. Waller.

Danbury—C. O. Brown, J. Sanders, E. B. Watson.

Darien—R. N. Green.

East Norwalk—R. D. Haven.

Greenwich—J. W. Cone, J. L. Gregory, P. L. Minor, S. E. Minor.

Norwalk—J. P. Wadhams.

Shelton—D. E. Brinsmade.

South Norwalk—S. W. Hoyt, Jr.

Stamford—P. Nash, H. A. Parsons, F. S. Wardwell.

Hartford County

Berlin—J. E. Boylan, C. F. Chase, J. T. Hart, F. G. Patience, S. C. Poriss, S. N. Robinson, G. H. Sage.

Bloomfield—A. C. Hall.

Burnside—P. Strout.

East Hartford—L. B. Comstock, H. B. Olmsted, C. H. Olmsted.

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Kolesch & Co.	Engineering Instruments	32
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Moore Trench Machine Co	Trench Machinery	4
Murdock, C. W.	General Contractor	32
New Haven Trap Rock Co., The	Trap Rock	14
Pacific Flush-Tank Co., The	Miller Automatic Siphon	18
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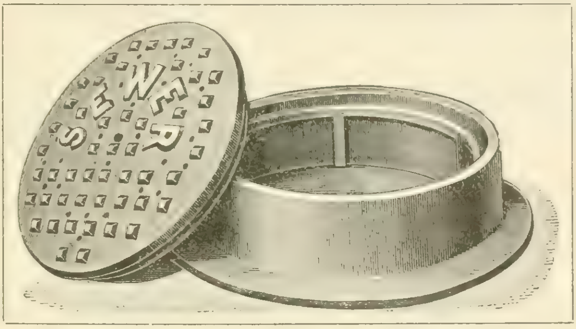

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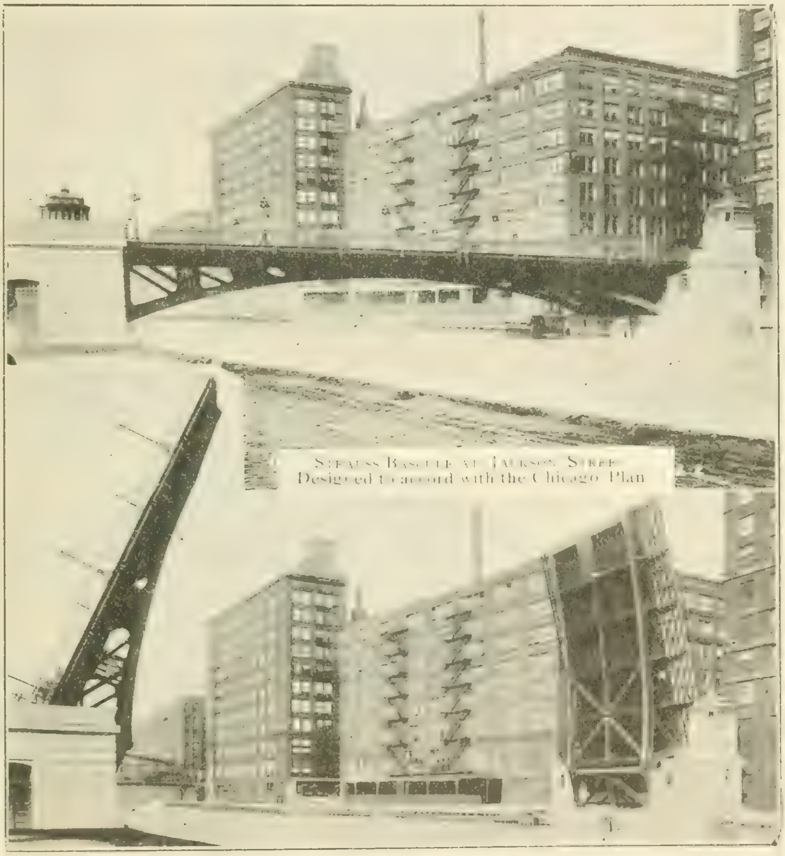

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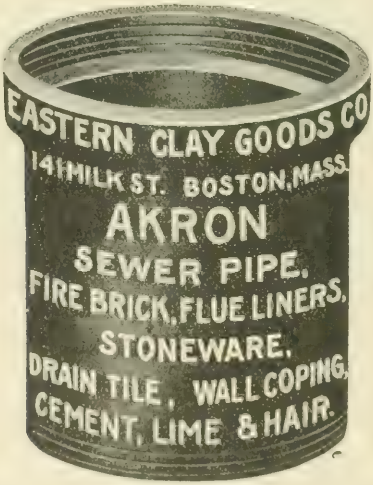

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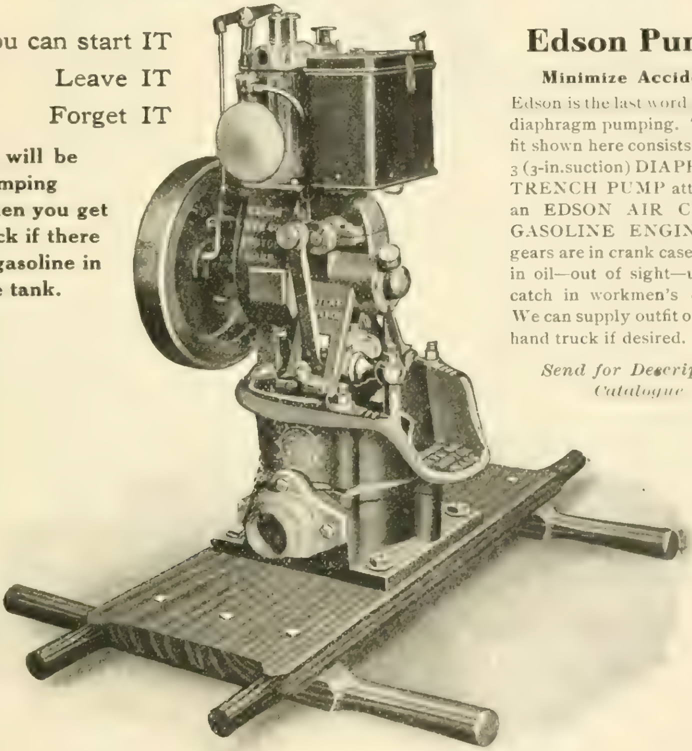

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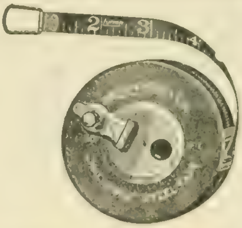

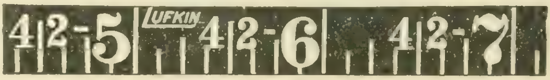

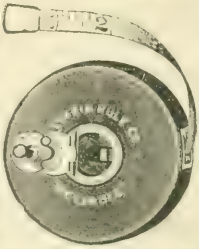

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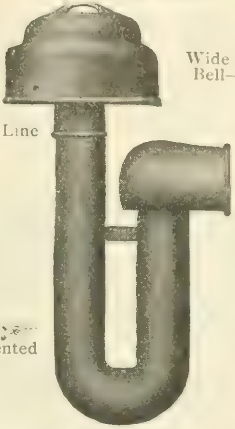

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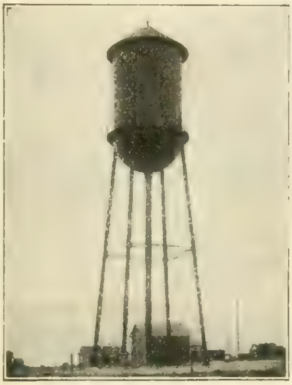

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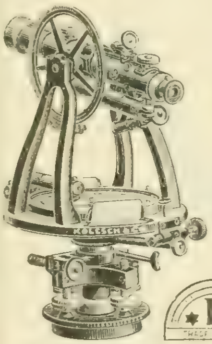

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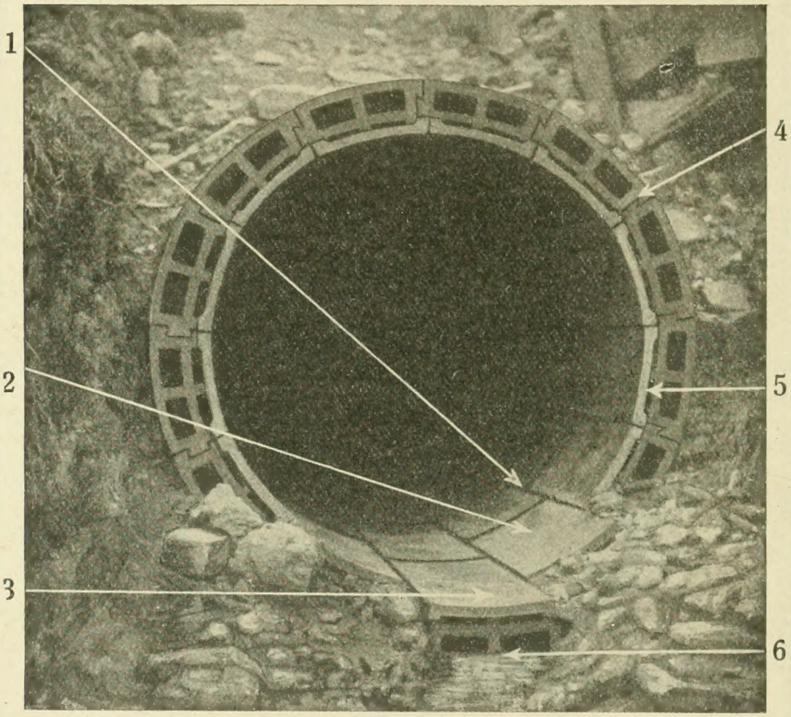

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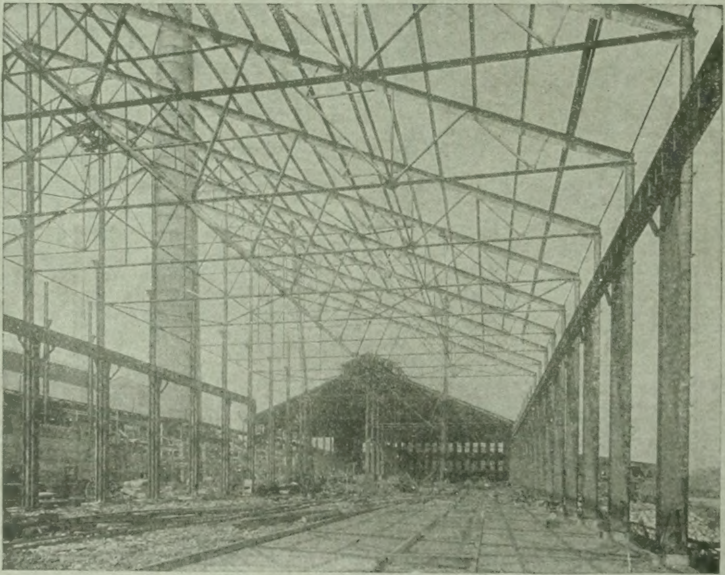

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